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Evaluation of Long Term Effects of Erosion Due to Groin Placement in the Northern Yucatan Peninsula

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EVALUATION OF LONG TERM EFFECTS OF EROSION DUE TO GROIN PLACEMENT

IN THE NORTHERN YUCATAN PENINSULA

by

Andrew Mahfood

(Under the Direction of Major N. Mike Jackson)

ABSTRACT

This thesis documents the results of a study conducted to evaluate the long term effects of groin placement on beach re-nourishment and beach restoration in the Yucatan peninsula. The study includes the evaluation of six control points located on Chelem beach in Yucatan, Mexico, very close to the Progreso pier. The control points were set up in an active groin field to record data on the re-nourishment project covering the Chelem beach area. These erosion control groins were constructed as part of an experimental project to see how the adopted U.S. Army Corps of Engineers guidelines, for installing groins, affected the re-nourishment of the beach.

The scope of this study is to document how placing groins using the USACE guidelines (transversally spacing them by a distance of three times their longitudinal length) affects the shoreline erosion patterns. The profile of the beach was generated by GPS technology and by utilizing the Emery-Method (Krause, 2004). The beach profiles were checked on a weekly basis to ensure the effects of the groins were being adequately monitored. A Beach Morphology Analysis Package (BMAP) model for shoreline evaluation was run to accurately display the displacement of sediment along the coast. Based on this modeling, conclusions are presented regarding groin placement to ensure optimal re-nourishment results.

The results presented herein validate that proper groin placement and engineering can greatly increase the successful re-nourishment of a beach. This study documents the importance of engineering the groins properly and placing them at correct distances and depths in order to achieve the greatest re-nourishment results. Using groins for beach re-nourishment has been a skeptical subject for many engineers because if they are not properly engineered, they can severely damage the beach. The results of this study show that after monitoring the controls points for a 6 month period, the profiles gained an average of 10 meters. This makes a case as to why beach re-nourishment projects using groins should be considered by engineers tasked with restoring a beach or a coastal area when it is deemed necessary.

INDEX WORDS: Chelem beach, Yucatan, Mexico, Progreso, groin, beach re-nourishment, USACE, erosion, GPS, Emery-Method, BMAP model, sediment.

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DEDICATION

This thesis is dedicated to my parents Phillip and Sophia Mahfood, as well as my brother Joseph Mahfood. Their guidance and love has molded me into the person I am today.

I also want to thank God because without him none of this would be possible.

and

Dr. N. Mike Jackson for guiding me through my master's degree.

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CHAPTER 1

INTRODUCTION

PURPOSE OF THE STUDY

The primary objective of this study was to closely monitor the six control points along Progreso beach in Yucatan, Mexico and document how the existing groin structures are impacting the erosion of the beach. A groin is a shore-connected beach stabilization structure used to regulate the sediment flow longitudinally (Engineers, 2002). Data has been collected on a weekly basis in order to determine the profile of the beach and assess the impact on erosion. This information has been used to show exactly where the sand is building up or being taken out to sea. The general rule of thumb that the distance between each groin should be three times longer than their length (Engineers, 2002) has been implemented on this stretch of beach, and throughout the study. As an example, if 20 meter long groins are being installed, each groin should be placed 60 meters away from each other. The installed groins are made of wooden posts driven into the sand and filled sand bags stacked inside the wooden posts which make them permeable allowing some water and sediment to naturally pass through them.

The secondary objective of this study was to take the data generated from the control points and use it to run the Beach Morphology Analysis Package (BMAP) program to calculate volumetric properties of the beach profiles using the Coastal Engineering Design and Analysis System (CEDAS) software (Center, n.d.). This model was used to depict the changes in volume to the profile and to determine the long-term effects the groin has on the re-nourishment of the beach over a set period of time. The results of this model were also compared with the real-time data that is collected on a weekly basis. Comparisons were made between the field data and the

BMAP outputs to see how the re-nourishment process was working and to also compare changes to the beach profiles to better assess if the groins were functioning properly and replenishing the beach. This research is unique because it is the first groin monitoring project conducted in Chelem Beach. The project location was selected due to concerns over shoreline erosion caused by the 6.8 km Progresso pier located just 5 km to the east of the test site. Without proper monitoring of the groin structures as they pertain to beach restoration, the problem could potentially get significantly worse and could cause property owners to lose their homes on the beach. This study will benefit not only the beach, as the aim is to fully restore it to a healthy state, but also the property owners whom are concerned about the impact of the shoreline erosion on their homes.

Figure 1: Functioning Groin to the West of Progreso

GROINS

Groins are structures that are perpendicular to the shoreline (Engineers, 2002). They can be constructed to be permeable or non-permeable depending on what the need is. Permeable groins allow for sediment to pass through them while still trapping sediment. On the other hand, non-permeable groins are solid structures that completely block the flow of sediment from passing through them. Groins are constructed to be whatever length the engineer deems necessary to complete the job. They are one of the most misused coastal structures by engineers because of the many factors that go into the design of them (Engineers, 2002). Groins structures have been shown to be very effective for beach re-nourishment and restoration when they are employed in the correct way. The challenge in using groins is twofold: first, little is known regarding the appropriate placement location and spacing outside some standard rules of thumb, and secondly, incorrect placement and spacing can have a devastating impact on the beach. As such, groins can be a major factor in beach restoration and re-nourishment or they can cause increased erosion if placed improperly. There are many factors that go into the proper design process of a groin. The design elements that must be accounted for when engineering a groin are (Engineers, 2002):

- littoral forces
- tides
- wind
- wave length
- wave height
- current

- depth of the water

Littoral forces are the forces responsible for the littoral drift of the sediment (Engineers, 2002). All of these elements are very important during the engineering process which is the main reason groins are difficult to implement correctly. The way a beach operates is one of the amazing natural phenomenon of the world. Many people enjoy a day at the beach without realizing exactly how a beach functions. Sand is constantly being transported longitudinally across the face of the shoreline depending on the direction of the long-shore current as well as being taken out to sea when the waves return to the ocean. These are all parts of the natural processes of the beach that cause erosion which is the reason beach re-nourishment techniques must be utilized. If no measures are taken to restore the beach, then the end product will be an eroded beach with limited sand.

The most common use for groins are to intercept the movement of sand along the shoreline. Groins should be considered in circumstances such as at divergent and nodal points for littoral drift, at the updrift side of an inlet entrance where intruding sand must be managed, to reduce the loss of beach fill, along the banks of inlets where tidal currents are strong, and along an entire littoral cell where sand is lost without return (Nicholas C. Kraus, 1994). There are also circumstances in which groins should not be used such as when cross-shore sediment transport is dominant, a large tidal range permits too much bypassing at low tide and overpassing at high tide, when constructed too long and impermeable causing sand to be jetted seaward, and when strong rip currents are created causing danger to swimmers (Nicholas C. Kraus, 1994). The biggest mistake a coastal engineer can make is to implement a groin where it is not needed.

This research project took place in Chelem Beach Yucatan, Mexico. This strip of beach is experiencing major erosion problems because of the Progreso pier (Figure 1) and also residents illegally constructing their own groins for personal beach gain. The problem with this practice is that the blind use of groins can negatively impact the natural balance along the shoreline and accelerate sand erosion. This has caused great concern among local residents and the engineers that are tasked with fixing the problem. It is a slow and gradual process but Axis Ingenieria is taking appropriate measures to correct this problem. The six control points along the beach that are being monitored are providing the information that is needed to help restore the beaches of the northern Yucatan coast.

CHAPTER 2

BACKGROUND

Beach nourishment can be described as mitigating the effects of the forces that cause erosion on the beach (Engineers, 2002). This study focused primarily on one coastal structure, the groin. There are many different components that go into designing a groin for an area of beach. This section briefly discusses the fundamental principles behind longshore sediment transport, proper groin usage, and previous research on the subject.

LONGSHORE SEDIMENT TRANSPORT

Longshore sediment transport, also known as littoral drift, can be defined as the displacement of sediment parallel to the shore (Engineers, 2002). There are many forces in effect that cause longshore transport. The profile of the beach will either remain the same or change due to the transport regimes. The forces that are acting on the beach will not cause any change to the profile of the beach if they are in an equilibrium state. Due to different forces, the transport of the sediment may be to the left or to the right (looking out to sea) at different parts of the year (Engineers, 2002). The net annual transport can be defined by specifying one term as positive and one term as negative. Q_R will be defined as the positive quantity while Q_L will be defined as the negative quantity. When they are put together the net annual transport (Q_{NET}) is defined as (Engineers, 2002):

$$Q_{NET} = Q_R + Q_L \qquad \text{(Equation 1)}$$

Where:

Q_{NET} = net annual transport

Q_R = right transport

Q_L = left transport

If the right transport (Q_R) is greater than the left transport (Q_L) then the net longshore sediment transport will be directed towards the right. Conversely, if Q_L is greater than Q_R then the net longshore transport will be directed towards the left (Engineers, 2002).

The gross annual transport (Q_{GROSS}) can be defined as the sum of temporal magnitudes of littoral transport irrespective of direction (Engineers, 2002).

$$Q_{GROSS} = Q_R + |Q_L| \qquad \text{(Equation 2)}$$

Where:

Q_{GROSS} = gross annual transport

Q_R = right transport

Q_L = left transport

Observe that since the Q_L term in equation 2 is inside the absolute value, Q_{GROSS} is the total amount of sediment that has been transported either to the right or the left. These two formulas are used for different engineering applications whereas, the net annual longshore transport is used for deposition vs. erosion applications while the gross annual longshore transport is used for finding shoaling rates in inlets and channels. While dealing with groins, the net annual longshore transport will be vital to see which direction has the most transport, which will determine where the groin should be placed (Engineers, 2002).

PREDICTING LONGSHORE SEDIMENT TRANSPORT

According to the coastal engineering manual, the longshore sediment transport process can also be described as the volume transport rate. The volume transport rate is inversely proportionate to the weight transport rate (Engineers, 2002).

$$Q_t = \frac{I_t}{(\rho_s - \rho) g (1 - n)} \qquad \text{(Equation 3)}$$

Where:

Q_t = volume transport rate

I_t = weight transport rate

ρ_s = mass density of the sediment grains

ρ = mass density of water

g = gravity

n = sediment porosity

This is an effective equation to use for predicting a sediment transport regime. By using I_t, density is incorporated in the weight transport rate (Engineers, 2002). This allows the (ρ_s-ρ) factor to account for the buoyancy of the sediment in the water. When predicting the sediment transport regime, it is assumed there is sufficient sediment to be transported. There are many different formulae for predicting longshore sediment transport. Another very common formula for predicting longshore sediment transport is the Coastal Engineering Research Center (CERC) formula. This formula is based on the assumption that the total longshore sediment transport rate is proportional to longshore energy flux (Ernest R. Smith, 2009). The formula is written as (Engineers, 2002):

$$I_y = \frac{K}{\sqrt{\gamma_b}} \rho g^{\frac{3}{2}} H_{sb}{}^{\frac{5}{2}} \sin(2\theta_b) \quad \text{(Equation 4)}$$

Where:

I_y = total immersed weight longshore sediment transport rate

K = empirical coefficient

ρ = density of water

g = acceleration due to gravity

H_{sb} = significant wave height at breaking

γ_b = the breaker index

θ_b = wave angle at breaking

The CERC formula can be tailored and calibrated to estimate the total longshore sediment transport rates with a reasonable confidence of (± 30-50 percent) for any particular site (Ernest R. Smith, 2009). The confidence interval of ±30-50 percent accuracy is under favorable conditions where parameters such as breaker type and grain size are left out of the formula (Ernest R. Smith, 2009). This means that the formula is accurate at predicting the longshore sediment transport rate with a flux of 30-50 percent error each way. When predicting longshore sediment transport, it is better to run tests and collect data from the field because this provides a true measure of what is going on as opposed to a scaled down laboratory test that cannot produce the same information. When tests are recreated and run in a laboratory setting, the results will be repetitive with not much to gain from doing them (Ernest R. Smith, 2009). In these particular cases, it is better to collect the data and use it for calculations.

According to the coastal engineering manual, there are many factors that must be accounted for when predicting the sediment transport regime. The wind plays a major role in sediment transport. Whichever direction the wind is consistently blowing is the direction most likely the sediment will be transported barring special situations such as wave diffraction or refraction which might alter the path of the sediment. The tide also plays a major role in sediment transport. Sediment will be transported depending on the tide and the rate will differ. Another major factor that effects the sediment transport regime is the current. The current is the major component of sediment transport. Whichever direction the current is flowing is the direction the sediment will be transported. When the current is combined with the other factors such as the tides, wind direction, wave size, and temperature, the result is a sediment transport regime that is unique to that area of the beach. Depending on the conditions, the transport regime could be completely different 10 miles down the shore. This is why predicting the sediment transport regime is not an exact science and many problems occur throughout the process that must be addressed (Engineers, 2002).

LONGSHORE SEDIMENT TRANSPORT ALONG THE NORTHERN YUCATAN COAST

The Yucatan coastline in Mexico is one of the most troubled stretches of beach in the world. Coastal erosion is a major issue not only in the Chelem beach area but throughout the whole region because of the improper use of groins. The Yucatan coastline is approximately 245 km in length, stretching from Celestun on the far west of the Yucatan coast to just above Cancun in the east. It has an average slope of 1/1000 (Cecilia Enriquez, 2009). The wind in this region of Mexico is predominantly from the northeast direction. The wind couples with the dominating current in the water that travels from east to west with a magnitude of 20 cm/s (Christian M. Appendini, 2012). This was measured in a previous study using an acoustic wave and current profiler (AWAC) at a depth of 10 meters (Christian M. Appendini, 2012). It is important to note that the majority of the waves in this region come from the northeastern direction, however the largest waves to hit the beach come from the northern direction. This has an effect on the sediment transport regime. Sediment transport is wave and current driven meaning that sediment moves in the path and direction of the waves and current. In the northern Yucatan peninsula, the sediment is being transported predominantly from the east to the west. Even though most of the sediment is moving from east to west, there is some sediment that moves from west to east. It is significantly less than the east to west transport, which is why the net annual transport will be positive in the western direction. The orientation of the northern Yucatan coast in relation to the wind and existing structures in the water creates numerous critical zones for erosion along the whole coast. Local residents have taken notice of the critical zones in the region since many of their properties lie within the critical zones. Longshore sediment transport is not the sole reason for the formation of these critical zones, as the use of improperly engineered groins by the local residents is also to blame (Nicholas C. Kraus, 1994).

EROSION IN THE NORTHERN YUCATAN COAST

As a result of the coastline orientation along the Yucatan region, there are many critical erosion zones. The critical zones must be handled with care to ensure the loss of beach is kept to a minimum. The problem with erosion in this area exists because of the lack of understanding the process of beach dynamic changes. Often many factors that affect erosion are neglected thus resulting in the loss of beach. The Yucatan coastline experiences mild wave conditions (hs=1m) which is a result of the predominant northeast wind that affects the area (M. Alejandra Lira-Pantoja, 2012). The term hs stands for significant wave height of the swell. Erosion is caused by wave conditions and also by improper usage of groins. In the case of the northern Yucatan shoreline, the main cause of erosion is the Progreso pier for the Chelem beach area, but improper usage of groins collectively affects the whole northern Yucatan coastline. Chelem beach is located approximately 5 km west of the Progreso pier. The Progreso pier is a 6.8 km long structure where the first 2.1 km is composed of arches that allow sediment to pass through. The pier was originally composed of the 2.1 km arched structure. Years later, an additional 4.7 km of impermeable structure was added to the pier bringing the total length to 6.8 km. The problem with the pier is that it acts as a 6.8 km groin that blocks the natural littoral drift from taking place. The movement of sediment is essential to maintain healthy beaches. The area to the right of the pier is not experiencing erosion problems because the direction of sediment transport is from east to west. Chelem Beach which is the area to left of the pier is experiencing the shallow effect, which is the effect that blockage of littoral drift has on the surrounding area. This causes the area to the left of the pier to be deprived of sediment that is naturally being transported by the current. The current is still in place however in Chelem beach which aids in the transport of sediment westward from Chelem. This problem has been addressed in a couple of different ways. One of such methods is through the usage of groin structures which are the most commonly used approach to help combat erosion. Although groins are very useful structures, in this region they are often not properly utilized. The majority of the landowners in Chelem are foreigners who seasonally visit during the summer and winter months. When they saw their beach was eroding, they illegally constructed groins without the proper engineering (Figure 2) in hopes of replenishing the sand on their property. However, when groins are not carefully installed, they have the same shallow effect on the adjacent area just like the Progreso pier and the area to the west of it (Figure 3). This is the root of the erosion problem in this area. According to Kraus, the correct way to get the erosion problem under control is to remove the old groins and properly install a collective set of adequately designed groins in the area (Nicholas C. Kraus, 1994).

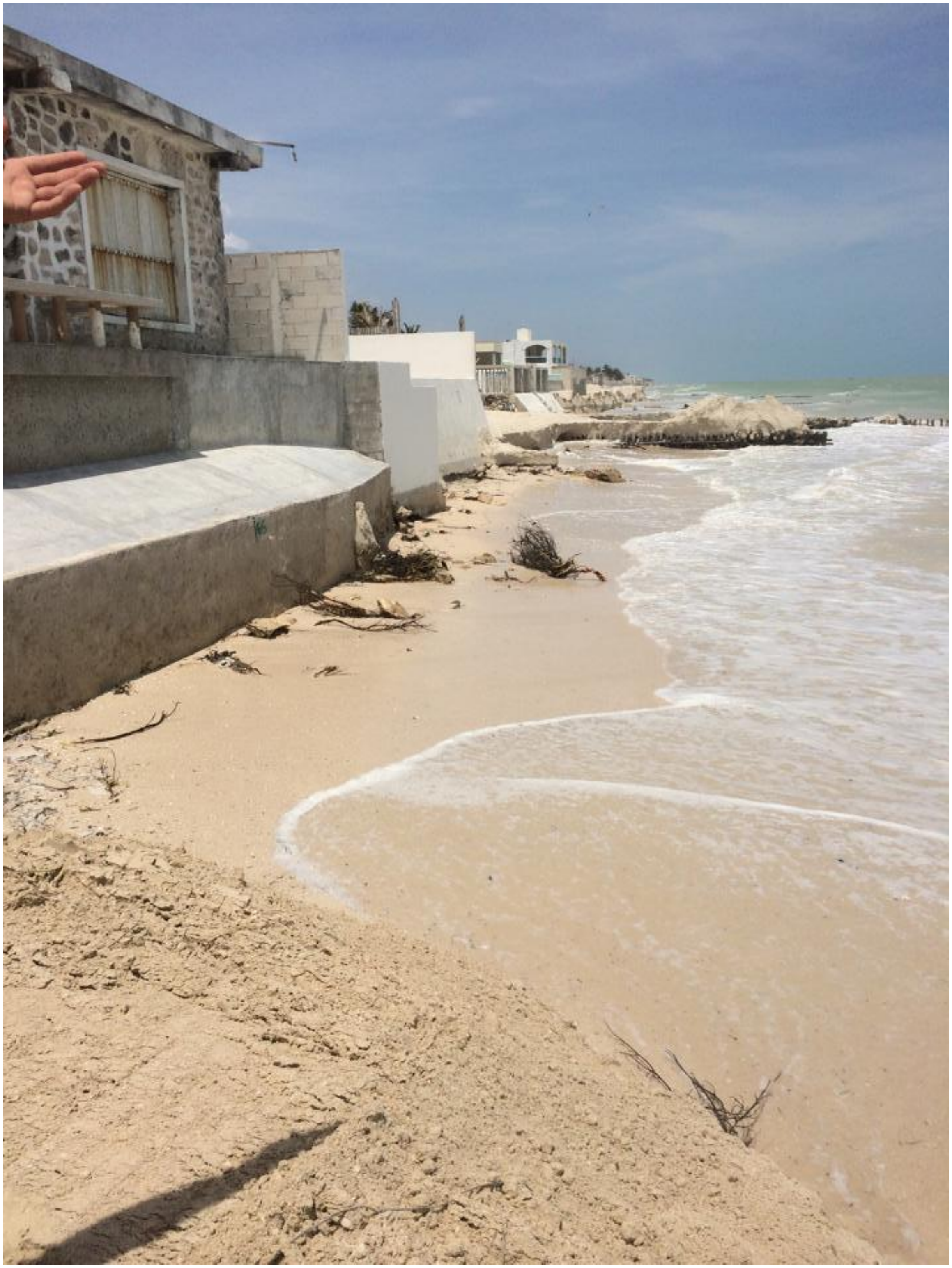

Figure 2: Critical Zone West of Progreso Pier

Figure 3: Critical Zone West of Progreso Pier

DEFINITION AND USE OF GROIN STRUCTURES

Groins are straight and relatively thin structures that are generally built perpendicular to the shore to prevent the normal transport of sand along the beach (Axis Ingenieria S.A. de C.V., 2014). The primary use of groin structures is to stabilize beach erosion caused by the movement of sand parallel to the shore. In the critical zones, these structures are mostly built of wooden stakes, sandbags, rubble, geotextile tubes, or any combination of these materials (Axis Ingenieria S.A. de C.V., 2014). While groins are an effective and common structure for erosion control on beaches, they must be installed under regulated criteria and optimal functional design features to meet the objectives of any project, which is generally to provide protection or restoration to the beach. According to the US Army Corps of Engineers (USACE), the recommended spacing of groins generally depends on the length of the individual groins. The distance between the groins must be at least 1.5 to 3 times the length of the groin, taken as the distance of the groin from the land out to the sea (Engineers, 2002). When selecting the height of the groin, the amounts of construction labor and efficiency to control the movement of sand must be considered (Axis Ingenieria S.A. de C.V., 2014). The groins can also be classified as high or low, depending on the altitude with reference to the normal levels of the beach (Axis Ingenieria S.A. de C.V., 2014). The groins have high ridges above the normal high tide level. Generally, no sediment is transported over the groin. Low crest groins have an elevation below the normal high tide level and can carry some sediment over the groin to the other side.

THE EMERY-METHOD

The Emery-Method is a very inexpensive alternative method to measure the profile of a beach. This method is very common in developing areas of the world such as Mexico and can function just as well as some of the more expensive methods. The Emery-Method was first introduced in 1961 by Kenneth O. Emery. It was originally composed of two surveying rods. The measurements were taken by reading the numbers on the rods in relation to the horizon to get and accurate reading (Emery, 1961). Since it was introduced, the method has evolved to improve the gathering data for beach profiling. The original method that was presented by K.O. Emery was the first to provide an approach for recording the profile of a beach. There were however some flaws with Emery's original method. The earth is not flat therefore using the horizon as a measuring point will lead to incorrect data. Thus a correction for the curvature of the earth's surface is needed. When the correction is applied, the true slope is steeper than the measured apparent slope (Francisco Andrade, 2006). When the horizon is not visible, such as in a lake or behind a tall dune, the approximate distance to a reference point must also be known (Francisco Andrade, 2006). Errors accumulate because elevation is obtained from the sum of the difference of pairs of readings (Francisco Andrade, 2006). Another disadvantage of the Emery-Method is that the rods are only 5 feet apart which leads to extensive time spent collecting data (Emery, 1961). While there are many noted downsides for using this method, there are many upsides as well. The most notable advantage is the cost which is considerably less expensive than using traditional surveying equipment. With the adaptations of the method it has become even more efficient and popular. The approach that is used today follows the same concept introduced by Emery in 1961, however, there are a few modifications. The first modification consists in using a transparent plastic hose that is 6 meters long and 1-1.2 centimeters in diameter. This hose is incorporated in the apparatus (Francisco Andrade, 2006). There are two transparent acrylic tubes that are 1.2-1.5 meters long and have the same diameter of 1-1.2 centimeters as the plastic hose (Francisco Andrade, 2006). There is also 5 meters of nylon string as well as two 90˚ plastic elbows that fit the plastic hose and acrylic tubes (Francisco Andrade, 2006). The plastic hose is inserted into the elbows and the acrylic tubes are inserted in the other side (Francisco Andrade, 2006). The tubes are parallel with the rods and filled with water to a height of approximately half of the rods. The theory behind how this works is based on the physical principle of communicating vessels which states that a fluid in communicating vessels forms a surface in hydrostatic equilibrium (Francisco Andrade, 2006). If both ends of a hose filled with water are equally graduated and placed vertically side by side, then different readings of water level in them will indicate differential elevation (Francisco Andrade, 2006). With these modern adaptations of the method it has become even more efficient and popular (Figure 4). More information concerning the usage of the Emery-Method in the methodology of the project is included in chapter 3.

Figure 4: The Emery-Method

PREVIOUS RESEARCH

The topic of erosion on the Yucatan coast has been an ongoing issue for the last several decades. Unfortunately, there has not been a great deal of research done on the topic of erosion caused by coastal structures which is the root of the problem in Chelem. However, there is one particular study that was done that is very informative on the topic. The study was done on the 6.8 km Progreso pier to evaluate the near-shore wave transformations and sediment transport patterns (M. Alejandra Lira-Pantoja, 2012). This study was set up using an acoustic Doppler current profiler (ADCP) that was installed at a depth of 8 meters in the ocean. The study concluded that there are high erosion rates caused by the blockage of sediment transport to the west of the Progreso pier. The erosion rate for Chelem beach was calculated to be about 1m/year (M. Alejandra Lira-Pantoja, 2012). As a result of this high erosion rate, there has been devastating coastal infrastructure damage along a stretch of 10 km of beach west of the pier including Chelem Beach. It is noted that because of wave diffraction, the sediment transport regime closest to the pier on the west side travels east. After the reversed sediment transport adjacent to the pier, it returns to a westward transport regime. The study has also shown that as a result of the pier being constructed, the mean wave height of waves west of the pier has decreased which in turn diminishes the summer profile beach recovery that would normally take place. The final conclusion of the study is that beach erosion in the Chelem area is enhanced by the presence of the 6.8 km pier and it directly decreases the beach recovery capability of the Chelem area (M. Alejandra Lira-Pantoja, 2012) (Figure 5).

Figure 5: Sand Brought in for Beach Re-Nourishment

ECONOMIC ANALYSIS

This project was priced at 50,000,000 Mexican Pesos, which is approximately $3,700,000 USD. The price was for the construction and installation of the groins as well as the geotextile breakwaters that were placed out in the Gulf of Mexico. The price of this project included installing the groins and the geotextile tube breakwaters over the distance of 17 kilometers. The groins were installed 50 meters apart from each other. The number of groins that were installed over the 17 kilometers was 340. The average price of constructing and installing a groin is 27,000 Mexican Pesos which is $2,000 USD. This means that to install the groins over the 17 kilometer stretch of beach it cost approximately $680,000 USD. The rest of the leftover money which is roughly $3,000,000 USD was used for the geotextile breakwater installation as well as some beach re-nourishment techniques such as importing sand by the truckload to place in various critical zones. While $3,700,000 USD is a significant amount of money to spend on a project, it is better to address the erosion problem in the correct manner rather than spend more money at a later date as a short term fix to the problem due to negligence of the situation.

CHAPTER 3

METHODOLOGY

As noted previously, the main objective of this study was to monitor six control points located on Chelem beach on the northern Yucatan coast, approximately 5 km west of the Progreso pier. The secondary objective of this study was to create and run a BMAP program to model the changes in the beach profiles that were recorded on a weekly basis from the six control points. The approach that was taken in this study was to do a preliminary GPS survey of a 17 km stretch of beach to allow the control points to be located based off of the critical zones. This was followed by a bathymetric survey of the ocean around the control points. At this point, the groins were installed on the beach based on extensive analysis of the sediment transport regime of the critical zones. The next step in the process was to monitor the beach profiles on a weekly basis from April 2014 to September 2014 using the Emery-Method. This was an important step in that it illustrated the amount of progress that was being made in the beach restoration process. The study was concluded by comparing data generated from the BMAP program to see changes in displacement and overall beach gain. This experiment was a lengthy process and it was conducted over the course of a year with the monitoring process lasting six months at Chelem beach on the northern Yucatan coast.

GPS SURVEY

The process started with a GPS survey of a 17 km stretch of beach that included Chelem beach which is the area with the six control points. The purpose of the GPS survey was to obtain data to generate a beach profile for analysis. A state of the art waterproof GPS system from Leica was used (Figure 6). The model was a Leica GS14 GS15 and GS09 receivers. They are capable of receiving GNSS RTK and radios of up to 35 watts of power. The GPS instrument was attached to a pulley with wheels so the beach profile could be obtained. The GPS was run from the beach into the water in one hundred meter intervals to obtain an extensive profile of not only the land but also the seafloor (Figure 6). The GPS started up on the beach where the sand was, and then it was walked all the way into the ocean about fifty meters out. It was set up to record the elevations in one second intervals. This allowed the GPS to obtain a very accurate beach profile. Since the profile was taken out into the water, it gave a better understanding of the true profile of the beach. A preliminary beach profile is needed to determine the critical zones. A critical zone is an area where the erosion is large enough to produce property damage and loss. The critical zones must be identified in order for the control points to be placed along the beach. They are placed at the critical zones for the sole purpose of monitoring those zones extensively through weekly beach profiling. The control points were placed on the beach by the Axis Ingenieria. They were monitored weekly by their surveying crew which I was a part of from May 2014- June 2014. GPS surveys of the 17 kilometer stretch of beach were conducted throughout the durations of the study.

Figure 6: GPS Survey of Beach

BATHYMETRIC SURVEY

The next step was to conduct a bathymetric survey in the water surrounding the six control points. A bathymetric survey is a survey that measures the water depths in a body of water. This information is used to profile of the ocean floor. The procedure for doing this type of survey is very straightforward. First, the lines to be followed by the boat conducting the bathymetric survey must be drawn in a CAD program. These lines are generated accurately using GPS coordinates. The lines extend out 3-5 km from the beach out to the ocean. This is done to obtain accurate results. The device that is used to conduct this survey is called an echo-sounder. The one used for this survey was a SYQWEST model 50MF. A Valeport Midas Surveyor with GPS integration was also employed to conduct the bathymetric survey. The echo-sounder is attached to the boat and submerged in the water throughout the data collection process. The echo-sounder transmits a pulse wave that is reflected off of the ocean floor and back to the device (Figure 7). This is how the depth is measured and relayed back to the computer. This is recorded in 1 second intervals for optimum results. The boat must then be positioned as close to the sand as possible to start the survey. The boat travels at a relatively slow speed of 4-5 knots in order to record the data. Once the line is completed, the boat goes on to the next one until all the data is recorded. This is important because the bathymetric survey when coupled with the beach profile gives a detailed description of the pattern of sediment transport. Is shows exactly where the sediment taken off the beach is deposited on the ocean floor. This is key to properly identifying where to place the groins. Bathymetric surveys were conducted regularly throughout the course of this study.

Figure 7: Collecting Bathymetric Data

EMERY-METHOD

At this point in the projects, the beach profiles were measured on a weekly basis. The method for doing so is called the Emery-Method which is a very simple yet accurate method which the background information was discussed in chapter 2. The materials needed for this method include: two leveling rods, a two meter long rope attaching the rods, a clear flexible pipe that runs from one rod to the other (open to the atmosphere at both top ends), and water to put in the clear pipe. This method is based on the concept of equilibrium. The clear pipe is connected to both leveling rods where the tops are open to the atmosphere. When water is placed into the clear pipe, it will balance out and be in equilibrium, with both water surfaces at the same level. The next step is to place one rod (land rod) on the control point which has a known elevation. The second rod (sea rod) must be extended all the way out towards the sea making a straight line. The next step is to record the elevations where the water level is marked off on both rods. By subtracting these two readings, we obtain the differences in elevation between the two involved ground points, at the base of the two rods. The data must be recorded in two columns, one column for land readings and one column for sea readings. Once this is done, the land rod will be placed where the sea rod was, and the sea rod will move two meters toward the ocean. This process is repeated until the rods make it to the water. The recorded data is then plotted starting with the known elevation of the control point. The data will yield the profile of the beach. This process was then repeated five more times for the other control points. This was done on a weekly basis to ensure the profile of the beach was closely monitored. The tides were accounted for while gathering beach profile data to ensure the consistency and validity of the data.

GROIN IMPLEMENTATION

When designing groins for implementation in the field, there are some criteria that must be taken into account. If the dominant wave forms an angle to the beach, it is usually recommended to place a breakwater to prevent erosion by wave turbulence at the tip of the groin (Axis Ingenieria S.A. de C.V., 2014). A breakwater is a structure anchored to the ocean floor that helps dissipate the energy of waves as they pass over. Breakwaters help to lessen the effect that waves have when they reach the beach, which is helpful in reducing erosion. If there is no preferred direction, it is usually placed normal to the coast. The groins installed to the west of Progreso were placed perpendicular to the beach to maximize the accruement of sediment. The winds from the north east make the perpendicular placement of the groins the logical choice as it had the greatest effect in nourishment. The groins should have a constant height from the background of the beach, avoiding the high walls that produce strong erosion and in some cases the destruction of the groin (Axis Ingenieria S.A. de C.V., 2014)

The groins that were installed in the 17 kilometer stretch of beach that includes Chelem were 15 meters long and placed at 50 meters center to center. These parameters were selected by Axis Ingenieria. The 50 meter distance is slightly longer than the specified distance of 3 times the length of the groin. This could still work because the spacing requirement is somewhat flexible. The formula allows for some variation in the separation distance between neighboring groins. The 6 control points were placed in Chelem beach approximately 5 kilometers to the west of the Progreso pier and they are located in the huge groin field that has been implemented in this area. The control points are placed consecutively 200 meters apart from one another. They cover a total distance of 1200 meters of beach (Figure 8). This allowed for more variability in the results which makes the findings more accurate than the former. The control points were placed in the area where the critical erosion zones were the worst. The purpose of this was to monitor the progression of the most eroded beaches in the region, and see the positive results at the end of the study.

Figure 8: Creating GPS Locations of Groins West of Progreso Pier

BMAP CROSS-SHORE MODELING

Coastal Engineering Design and Analysis System is a very powerful software that has the capability to model certain scenarios involving erosion and sediment transport on beaches. The CEDAS software analyzes morphologic and dynamic properties of beach profiles for erosion using BMAP. The scenario in Chelem beach and all the area to left of the Progreso pier is a very unique situation. The pier is very long and is considered the longest in the world. This creates unpredictable conditions of erosion down-drift which is hard to model in software unless the parameters are very accurate. The CEDAS software takes into consideration many different factors when running the BMAP interface. The process starts by developing an input of beach profile coordinate data for BMAP. This is done by importing the beach profile data recorded from the Emery-Method into the program. Since there are six different control points analyzed in this study, six different sets of profile data were imported. In order to achieve an accurate comparison of the changes made to the beach profiles, only two profiles were imported for each control point (the original beach and last beach profiles). The original beach profile was taken on April 1st, 2014 while the last one was completed on September 10th, 2014. By doing this, a direct comparison was made by the CEDAS program to analyze the profiles and see the positive and negative changes. The program calculated the volume increase or reduction between the two profiles for each control point. The BMAP program also calculated the increase or decrease in the total length of the profile. This is a powerful software package that resulted useful in analyzing the six control points.

CHAPTER 4

ANALYSIS OF FINDINGS

The project on restoring Chelem Beach located 5 kilometers west of the Progreso pier has been an ongoing process for the last couple of years. Numerous projects have been undertaken with not much success. The groins engineered and installed by Axis Ingenieria have been in place for a little under a half of a year and are being monitored weekly using the Emery-Method to gather data. As the data was collected weekly, it was also analyzed to make sure the groins were performing as they were supposed to. The results of these findings and observations are presented in the following sections. The six control points have been set up roughly 200 meters apart from each other, encompassing approximately 1200m of Chelem Beach (Figure 9). Figures 10-15 so the morphological change of the profiles over the 6 month monitoring process where 0 on the graphs is the location of the control points.

Figure 9: Overhead View of the 6 Control Points

CONTROL POINT 1

Control Point 1 is located approximately 5 kilometers west from the 6.8 km Progreso pier (Figure 9). The sediment transport erosion problem starts just west of the pier which is why the control points were set up starting in this location and going westward. At this location there is an existing concrete slab that extends out into the ocean which is acting like an impermeable groin. This structure is attached to a house (Figure 3). Although the house is not supposed to be exposed to the water, the erosion is so large that the house is no longer safe to live in and the erosion downdrift from it at control point 1 is very strong. This is the primary reason why the government decided to use groin structures in this area of the shoreline. The original profile of the beach at control point 1 extended out to approximately 28 meters from the top of the profile measured out to the water when initially measured on April 1st, 2014. As mentioned earlier, the tides were taken into account when measuring the profiles in order to keep the data consistent. After analyzing the groin on a weekly basis, data from this control point shows that the beach profile has regressed (Figure 10). The last Emery-Method profile that was taken on September 10th, 2014 shows that the profile extended only to approximately 24 meters. One possible reason for this is the concrete slab that is exposed to the ocean that is adjacent to the control point. This slab is causing major erosion problems with sediment transport downdrift to the control point because of its close proximity. The best way to correct this is to completely remove the slab. However, this is not currently possible because the slab is part of the house and the local authorities do not have permission to remove the structure. After running the CEDAS program, it was determined that there was a reduction in the total volume of sand in the profile by 12.401 cubic meters. The horizontal length of the profile measured from the start of the sand on the beach out to the water also receded by 6.76 meters. Axis Ingenieria has proposed to combat this issue by installing geotextile tube breakwaters out in the ocean to lessen the effects the waves have on the sediment on the beach. By doing this, less sand will be taken out to sea which will allow for more sand to build up on the groins by the long-shore current. This is not a process that can be corrected in a short amount of time as it will take many months for the process to start showing results.

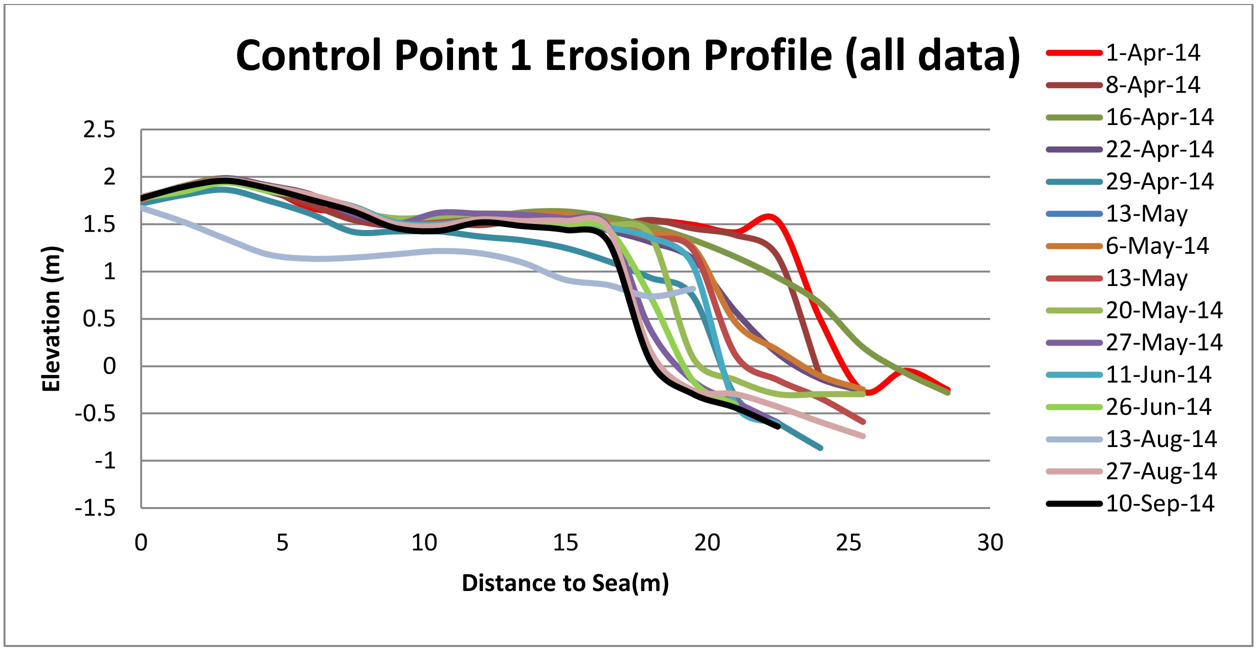

Figure 10: Control Point 1 Historical Data

CONTROL POINT 2

Control point 2 is located just west of control point 1 by roughly 200 meters (Figure 9). This is the second control point in the series of 6 points that are being monitored for erosion. The initial profile taken on April 1st, 2014 indicated there was 22 meters of sand from the control point to the water. The most recent recording from September 10th, 2014 has shown the profile of the beach has replenished itself and extended out to approximately 27 meters long (Figure 11).

As shown in the figure, the initial profile taken on April 1st, 2014 shows a very large vertical buildup of sand. This is due to the erosion rate in conjunction with the tides causing changes in the elevation of sea level and taking massive amounts of sediment off the beach at once. The length of the profile may have increased but by doing so, the total volume of the profile was reduced by 6.209 meters according to the CEDAS software. This shows the groins are working however a negative volume reduction did occur. The negative volume is due to the volume change being measured in reference to the datum line of 0. This means anything located below 0 mean sea level on the graph is calculated as negative volume. This is why a gain in total beach length coupled with a reduction in total volume is possible. As is the case with control point 1, coupling control point 2 with geotextile tube breakwaters would have an even more positive effect on the erosion problem at this control point. The farthest that the beach profile extended out to was about 32 meters. It is not bad that the profile receded from the high measurement of 32 meters. There are different parameters that affect the outcomes of erosion and they are all natural processes of the beach. The weather has a significant outcome in beach erosion and it is a big factor in the flux between the beach profile measurements. Overall, the result for control point 2 is positive in that the profile of the beach has grown to a healthier state than when the experiment started.

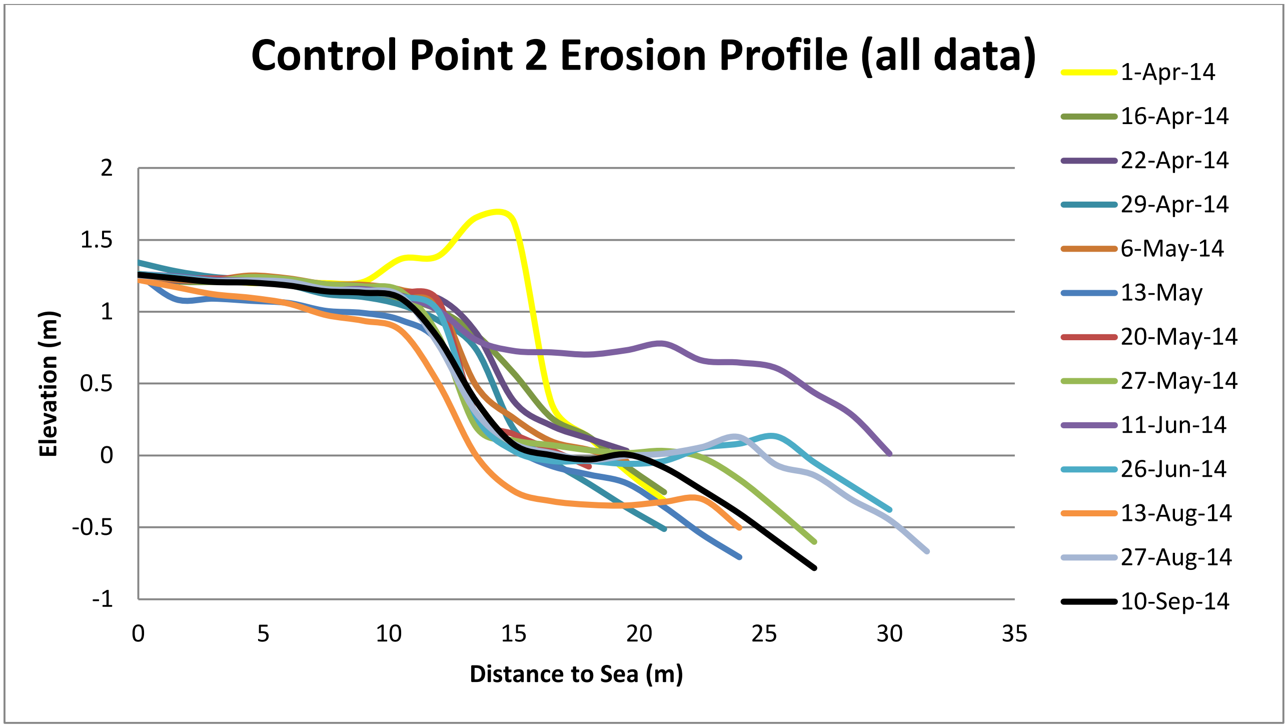

Figure 11: Control Point 2 Historical Data

CONTROL POINT 3

Control point 3 is located to the west of control point 2 by 200 meters (Figure 9). Control point 2 is more of a critical zone according to the data than control point 3. The initial profile was taken on April 1st, 2014 and it extended to 21 meters. This was actually worse than that of control point 2 however the results now are far better. The final beach profile taken on September 10th, 2014 measured the profile to be at 35 meters (Figure 12). This is very significant because it validates the basis of the research of how the groin structures positively affect the restoration of the beach. Control point 3 has gained 14 meters of beach in the six months that the groins have been installed and monitored. The reason for this is that control point 3 is downdrift enough from control point 1 and the slab of concrete in the water that it doesn't affect control point 3 as much as it does control point 2. This has enabled the restoration process to proceed at a faster pace at control point 3 than at control point 2. Theoretically speaking control points 4, 5, and 6 should have larger profiles due to the fact that they are farther downstream than control points 1, 2, and 3. This control point did however have a slight reduction in total volume of 0.182 cubic meters according to the CEDAS software. This is not a concern because the original profile was stacked high with sediment and when that was corrected by the groin systems, the profile increased in length.

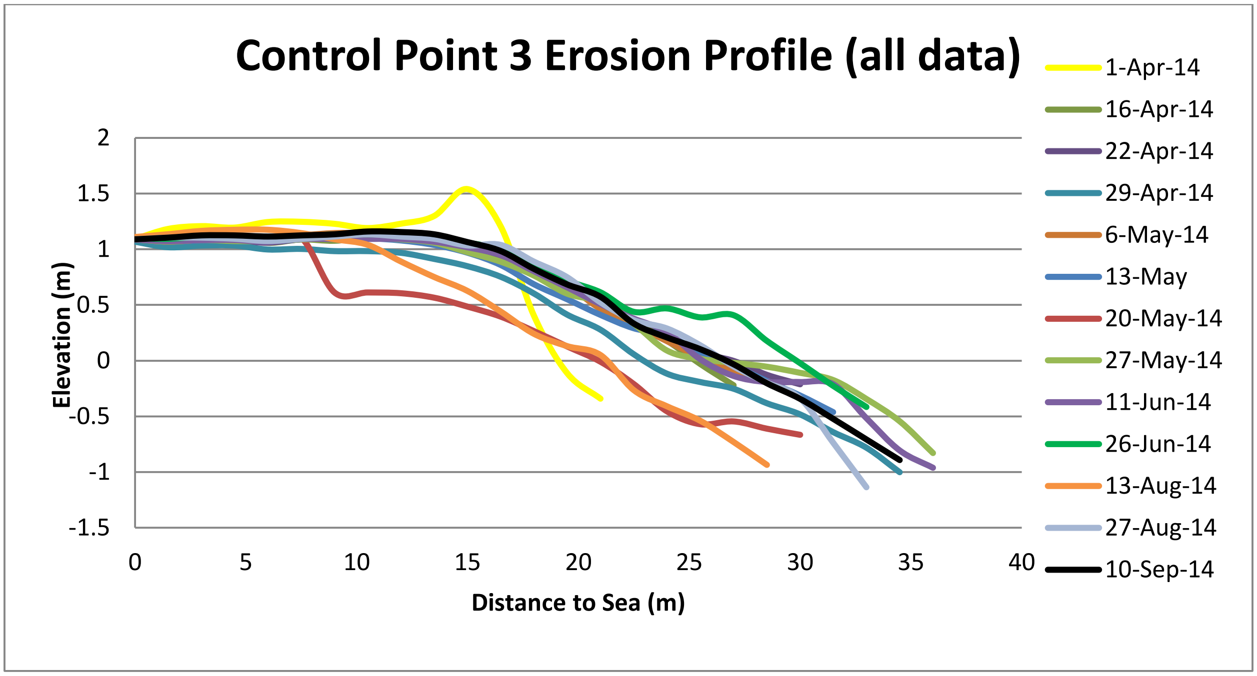

Figure 12: Control Point 3 Historical Data

CONTROL POINT 4

Control point 4 is 200 meters downstream to the west of control point 5 (Figure 9). The initial profile of the beach taken on April 1st, 2014 gave an initial length reading of about 21 meters of beach. As shown in figure 13, the profile was initially undernourished to a severe state.

This control point was initially worse than the previous 3 control points. This is a very similar value to all the other initial beach profile measurements from the other control points. The final reading of the beach profile was a reading of approximately 30 meters (Figure 13). This means the beach gained roughly 9 meters of sand over the 6 months since the groins have been up. This is very significant because it displays that some of the sediment is being trapped by the groin which is nourishing the beach. This is a positive result because the control points are in the critical zones where the beaches are at risk of further loss. Not only has the beach gained 9 meters of beach, but it also has gained roughly a meter of elevation in sediment buildup. This means the volume of sand that has been used to replenish the beach is larger than it initially appeared. The volume of this profile has more than doubled according to the CEDAS software from 10.258 cubic meters to 24.379 cubic meters. This is a good result because it is setting up the beach to be able to sustain itself for the long term. Control point 4 is the best result so far out of the first four control points.

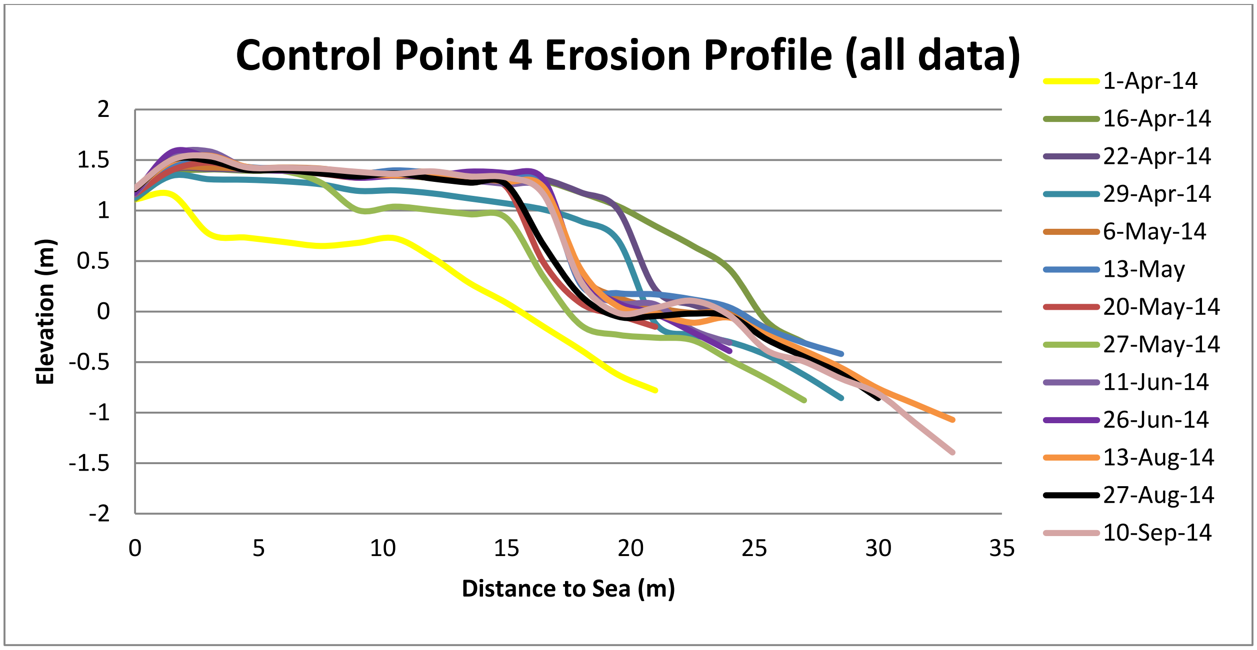

Figure 13: Control Point 4 Historical Data

CONTROL POINT 5

Control point 5 is located to the west of control point 4 by 200 meters (Figure 9). The initial profile measure that was conducted on April 1st, 2014 had a distance of around 20-21 meters. This value lines up accurately with the initial profile readings from all the other control points. The final profile reading that was conducted on September 10th, 2014 had a reading of 30 meters (Figure 14). This is also very similar to control point 4 just 200 meters to the east. The initial and final readings are very similar however there is a noticeable difference in the elevations of the two profiles. While the elevation of the profile for control point 4 gained approximately 1 meter throughout the 6 months this project has been carried out, the elevation of the profile from control point 5 has gained just a couple of inches over the same six-month period. The possible reasons for this could be the permeability of the groin set up by the control point. Since the groins are made with wooden posts and bags filled with sand stacked inside them, each groin will allow a different amount of sediment to pass through it. There was a slight reduction in the total volume of the profile according to the CEDAS software of 1.594 cubic meters. So while the groin is still working by replenishing the beach, it could be allowing more sediment pass through than the groin associated with control point 4 which doesn't allow control point 5 to increase the elevation.

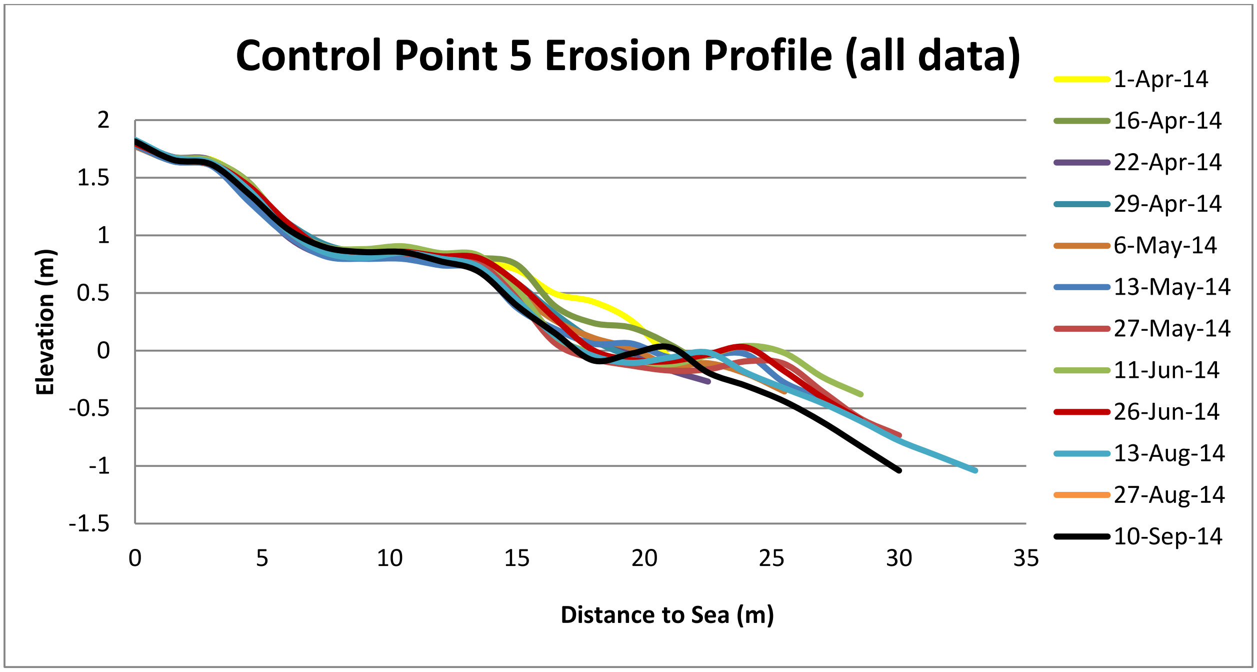

Figure 14: Control Point 5 Historical Data

CONTROL POINT 6

Control point 6 is located 200 meters to the west of control point 5 (Figure 9). This is the final control point that was set up and utilized for this experiment. This point lies approximately 5 km west of the Progreso pier. Control point 6 was arguably located in the second most critical zone (control point 1 is located in the most critical zone). The initial beach profile measurement taken on April 1st, 2014 had a reading of 18 meters which is below the average initial readings from all the other control points of approximately 20 meters. The final measurement reading that was taken for this control point on September 10th, 2014 had a reading of 27 meters (Figure 15). The beach profile for control point 6 gained 9 meters of beach throughout the 6 month monitoring process. There was a total volume change of 9.399 cubic meters according to the CEDAS software. This is very positive once again because it validates that the groins are doing their job in restoring the beach. The vertical component of this beach profile is different from control point 5's profile because control point 6 gained close to a meter of elevation from start to finish of the monitoring process.

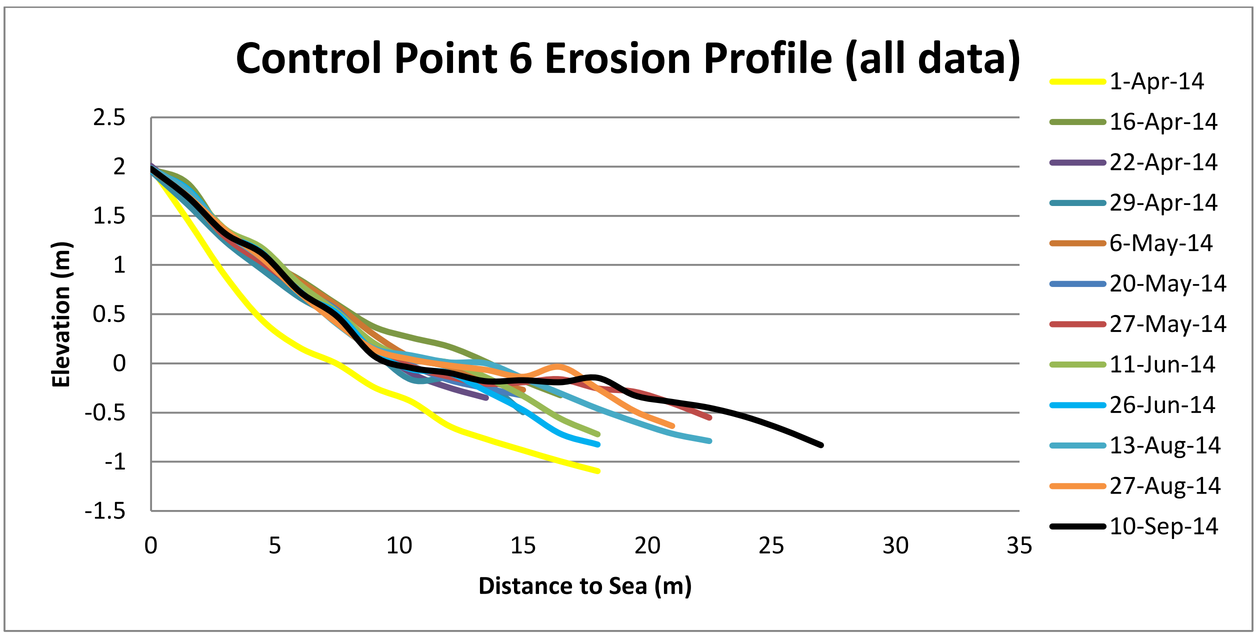

Figure 15: Control Point 6 Historical Data

CHAPTER 5

CONCLUSIONS

The objective of this study was to evaluate the long term effects that groin placement has on erosion on the northern Yucatan coast. Groins are coastal engineering structures that are used to combat erosion in critical zones. While there are no specific criteria or formulas related to the placement and installation of groin structures, the study followed the guidelines set forth in the U.S. Army Corps of Engineers (USACE) coastal engineering handbook. The groins used in this analysis were 15 meters long and were placed 50 meters apart from each other covering the span of 17 kilometers of continuous beach to the west of the Progreso pier.

The Emery-Method was used to obtain beach profile data for 6 control points that were located approximately 5 km west of the Progreso pier. Survey data was collected on a weekly basis to ensure the profiles were being monitored closely. Based on the data collected, the following conclusions were developed:

- The Progreso pier is the first cause of erosion for the beaches located to the west of it. The length of the pier causes the shallow effect to take place which blocks the sediment from accruing on the beaches directly adjacent to it. This causes erosion problems downdrift because of the lack of sediment.
- The severe cases of erosion in the northern Yucatan peninsula are secondly caused by the improperly constructed and placed groins throughout the region. The groins that were set up were not properly engineered thus disrupting the natural flow of sediment and creating critical erosion zones in certain areas.
- Control points 3, 4, 5, and 6 were experiencing the worst erosion problems as the starting average length of the profiles on the initial profile reading were 20 meters. All four of these control points experienced significant nourishment throughout the course of the analysis. The last profile reading for all four control points averaged 32 meters which is 12 meters of beach gained.
- Control point 1 is the only area that experienced a regression in nourishment. This regression is justified by the concrete slab that is located adjacent to the east of the control point. This slab acts as an impermeable groin thus creating a critical zone downdrift at the control point. The regression was moderately significant as the difference between the initial and final profile measurements was 6 meters.

- While the majority of the control points gained length in the profiles, some of them did experience a total reduction in volume. This is due to the fact that the volume reference datum line is being measured from 0 mean sea level. This is how the beach can experience gains in total beach length while simultaneously experiencing a reduction of total volume.

It should be noted that while the results drawn from this study for some of the control point's data are negative, the overall results are a success. The control points that have negative results also have positive results to go along with it. The groins are set up in a way where the nourishment of the beach will be successful. As previously stated, the beach works in cycles where sand is taken from shore and stored in a sandbar out in the ocean for months at a time. It is a natural process that takes place and therefore it must be recognized that sand returning to the ocean does not mean the groins are unsuccessful at nourishing the beach. It means the beach is carrying out its natural process where sediment is being moved around. From the data that has been collected, the groins have been successful in nourishing the critical zones of the northern Yucatan coast.

RECOMMENDATIONS

The purpose of this study was to evaluate the long term effects that installing properly engineered groins in critical erosion zones has on erosion patterns. The preliminary results indicate that the groins have been successful in nourishing the critical zones to the west of the Progreso pier. There has been significant gains in sand deposited on the beach from the use of the groins in terms of horizontal length and elevation. Throughout the 6 months of monitoring, the control points gained approximately 10 meters of beach which is a positive sign.

It is recommended that future research should be conducted in the northern Yucatan peninsula concerning the effects that geotextile breakwater tubes installed off-shore have on the sediment transport regime and critical zone erosion patterns. This information would particularly helpful to the coastal engineers in the region.

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APPENDIX A

Table 1: Control Point 1 Historical Data

Control Point 1			Elevation	1.804	X	214133	Y	2354373						
X	1-Apr-14	8-Apr-14	16-Apr-14	22-Apr-14	29-Apr-14	6-May-14	13-May	20-May-14	27-May-14	11-Jun-14	26-Jun-14	13-Aug-14	27-Aug-14	10-Sept-14
0	1.7443	1.7293	1.7543	1.7723	1.7193	1.7543	1.7633	1.7793	1.7743	1.7743	1.7743	1.6743	1.7893	1.7743
1.5	1.8843	1.8873	1.9043	1.9053	1.8093	1.9043	1.8853	1.8993	1.8843	1.8793	1.8443	1.5243	1.8943	1.8943
3	1.9543	1.9473	1.9893	1.9853	1.8643	1.9793	1.9753	1.9693	1.9543	1.9743	1.9393	1.3443	1.9643	1.9593
4.5	1.8743	1.8473	1.8993	1.9103	1.7493	1.8993	1.8953	1.8943	1.8693	1.8893	1.8493	1.1793	1.8993	1.8793
6	1.6693	1.7043	1.7893	1.8153	1.6093	1.8093	1.7893	1.8093	1.7793	1.7893	1.7743	1.1343	1.8093	1.7593
7.5	1.6293	1.5443	1.6693	1.6003	1.4193	1.6293	1.6513	1.6493	1.6143	1.6893	1.6343	1.1463	1.6793	1.6343
9	1.4793	1.4793	1.5013	1.5183	1.4243	1.5443	1.5133	1.5643	1.5043	1.5193	1.4993	1.1813	1.4993	1.4593
10.5	1.5193	1.5193	1.5263	1.5483	1.4243	1.5793	1.5423	1.5843	1.6193	1.4993	1.4793	1.2163	1.4793	1.4293
12	1.5343	1.4893	1.5613	1.5323	1.3693	1.6093	1.5623	1.6143	1.6093	1.5493	1.5493	1.1913	1.5493	1.5193
13.5	1.5143	1.5443	1.6263	1.5673	1.3293	1.6073	1.5673	1.6043	1.5993	1.5293	1.5193	1.0913	1.5343	1.4793
15	1.5143	1.5193	1.6363	1.5323	1.2493	1.6073	1.5423	1.5543	1.5593	1.5243	1.4993	0.9113	1.5343	1.4393
16.5	1.4943	1.4743	1.5763	1.4373	1.1093	1.5173	1.4763	1.4943	1.4843	1.4643	1.4393	0.8563	1.4593	1.3193
18	1.5393	1.5443	1.4763	1.3123	0.9343	1.4173	1.3523	1.3843	0.3843	1.3593	0.7293	0.7363	0.1543	0.0493
19.5	1.4943	1.4543	1.3363	1.1323	0.7393	1.2573	1.2273	0.0893	-0.1557	1.0693	-0.1567	0.8163	-0.2557	-0.2957
21	1.4143	1.3843	1.1563	0.5773	-0.3207	0.4623	0.1173	-0.1457	-0.3807	-0.4027	-0.4067	-	-0.2957	-0.4407
22.5	1.5343	1.1543	0.9363	0.1323	-0.6007	0.1673	-0.1487	-0.2957	-0.5957	-0.6077	-	-	-0.4307	-0.6407
24	0.4943	-0.1157	0.6613	-0.1327	-0.8657	-0.1027	-0.3387	-0.2957	-	-	-	-	-0.5907	-
25.5	-0.2657	-	0.2013	-0.2627	-	-0.2477	-0.5887	-0.2957	-	-	-	-	-0.7407	-
27	-0.0507	-	-0.0707	-	-	-	-	-	-	-	-	-	-	-
28.5	-0.2507	-	-0.2807	-	-	-	-	-	-	-	-	-	-	-

Table 2: Control Point 2 Historical Data

Control Point 2			Elevation	1.392	X	214522.17	Y	2354462.4						
X	1-Apr-14	8-Apr-14	16-Apr-14	22-Apr-14	29-Apr-14	6-May-14	13-May	20-May-14	27-May-14	11-Jun-14	26-Jun-14	13-Aug-14	27-Aug-14	10-Sept-14
0	1.2573	-	1.2623	1.2623	1.3423	1.2623	1.2623	1.2623	1.2648	1.2623	1.2623	1.2223	1.2523	1.2573
1.5	1.2213	-	1.2123	1.2173	1.2823	1.2223	1.0873	1.2373	1.2398	1.2473	1.2423	1.1723	1.2323	1.2323
3	1.2313	-	1.2073	1.2223	1.2423	1.2223	1.0913	1.2323	1.2173	1.2223	1.2173	1.1223	1.2123	1.2073
4.5	1.2003	-	1.2123	1.2123	1.2223	1.2523	1.0763	1.2323	1.2423	1.2173	1.2123	1.0973	1.2173	1.2023
6	1.2103	-	1.1973	1.1923	1.1873	1.2323	1.0613	1.2173	1.2273	1.2023	1.1973	1.0573	1.2073	1.1823
7.5	1.1993	-	1.1453	1.1623	1.1223	1.1923	1.0063	1.1773	1.1923	1.1523	1.1523	0.9773	1.1573	1.1423
9	1.2083	-	1.1353	1.1443	1.1023	1.1873	0.9913	1.1723	1.1773	1.1573	1.1373	0.9373	1.1473	1.1323
10.5	1.3683	-	1.0923	1.1073	1.0473	1.1523	0.9413	1.1373	1.1423	1.1123	1.1043	0.8673	1.1073	1.0923
12	1.3893	-	1.0123	1.0923	0.9373	1.0423	0.7863	1.0723	0.8323	1.0073	1.0013	0.4973	0.7673	0.8123
13.5	1.6563	-	0.8403	0.8523	0.7373	0.4823	0.2563	0.2823	0.1973	0.8023	0.2713	-0.0027	0.2973	0.3773
15	1.6263	-	0.5723	0.3773	0.1823	0.2573	0.0463	0.1473	0.1048	0.7273	0.0313	-0.2477	0.0823	0.0773
16.5	0.3663	-	0.2623	0.2073	-0.0377	0.0973	-0.0737	0.0373	0.0723	0.7173	-0.0387	-0.3177	0.0173	0.0023
18	0.1263	-	0.1303	0.1173	-0.1977	0.0373	-0.1337	-0.0777	0.0373	0.7023	-0.0387	-0.3427	-0.0327	-0.0277
19.5	-0.1087	-	-0.0747	0.0323	-0.3627	-0.0427	-0.1937	-	0.0173	0.7323	-0.0587	-0.3477	-0.0027	0.0073
21	-0.3137	-	-0.2547	-	-0.5127	-	-0.3587	-	0.0323	0.7773	-0.0387	-0.3227	0.0123	-0.0827
22.5	-	-	-	-	-	-	-0.5487	-	-0.0127	0.6613	0.0513	-0.3027	0.0573	-0.2377
24	-	-	-	-	-	-	-0.7087	-	-0.1652	0.6463	0.0813	-0.5027	0.1273	-0.4027
25.5	-	-	-	-	-	-	-	-	-0.3752	0.6063	0.1313	-	-0.0677	-0.5927
27	-	-	-	-	-	-	-	-	-0.6002	0.4363	-0.0487	-	-0.1377	-0.7827
28.5	-	-	-	-	-	-	-	-	-	0.2813	-0.2137	-	-0.3077	-
30	-	-	-	-	-	-	-	-	-	0.0113	-0.3787	-	-0.4477	-
31.5	-	-	-	-	-	-	-	-	-	-	-	-	-0.6677	-

Table 3: Control Point 3 Historical Data

Control Point 3			Elevation	1.168	X	214331.34	Y	2354415.7						
X	1-Apr-14	8-Apr-14	16-Apr-14	22-Apr-14	29-Apr-14	6-May-14	13-May	20-May-14	27-May-14	11-Jun-14	26-Jun-14	13-Aug-14	27-Aug-14	10-Sept-14
0	1.0914	-	1.0934	1.0954	1.0684	1.0884	1.0884	1.0884	1.0884	1.0884	1.0984	1.1084	1.0884	1.0884
1.5	1.1814	-	1.0824	1.0754	1.0184	1.0684	1.0684	1.0684	1.0684	1.0734	1.0934	1.1334	1.1034	1.1034
3	1.2064	-	1.0574	1.0704	1.0334	1.0884	1.0784	1.0834	1.0834	1.0834	1.1134	1.1634	1.1034	1.1234
4.5	1.1934	-	1.1124	1.0754	1.0334	1.0984	1.0784	1.0784	1.0734	1.0834	1.1134	1.1734	1.0934	1.1234
6	1.2434	-	1.0574	1.0604	0.9984	1.1034	1.0684	1.0764	1.0734	1.0684	1.0934	1.1734	1.0734	1.1134
7.5	1.2454	-	1.0874	1.0904	1.0034	1.1234	1.0884	1.1014	1.0884	1.0934	1.1134	1.1434	1.0934	1.1234
9	1.2274	-	1.0754	1.0954	0.9834	1.1434	1.0984	0.6114	1.0934	1.0934	1.1334	1.0884	1.1134	1.1334
10.5	1.1894	-	1.1054	1.0954	0.9834	1.1434	1.0984	0.6114	1.0984	1.0934	1.1334	1.0384	1.1334	1.1584
12	1.2284	-	1.1104	1.0954	0.9684	1.1384	1.0784	0.6044	1.0884	1.0934	1.1334	0.8884	1.1134	1.1534
13.5	1.2977	-	1.0554	1.0654	0.9134	1.1184	1.0384	0.5644	1.0584	1.0684	1.1134	0.7494	1.0934	1.1334
15	1.5387	-	1.0204	1.0204	0.8484	1.0384	0.9684	0.4844	0.9734	1.0184	1.0584	0.6244	1.0334	1.0634
16.5	1.2037	-	0.9504	0.9404	0.7534	0.9584	0.8584	0.3944	0.8884	0.9484	1.0034	0.4394	1.0384	0.9834
18	0.4027	-	0.8404	0.7954	0.6034	0.8184	0.6854	0.2644	0.7634	0.8034	0.8584	0.2394	0.8884	0.8234
19.5	-0.1123	-	0.7204	0.6474	0.4134	0.6734	0.5504	0.1264	0.6009	0.6584	0.7184	0.1294	0.7484	0.6834
21	-0.3403	-	0.5654	0.4874	0.2784	0.4634	0.4104	-0.0106	0.5259	0.5084	0.6134	0.0494	0.5234	0.5734
22.5	-	-	0.3704	0.3274	0.0584	0.3284	0.2904	-0.2106	0.3309	0.3784	0.4384	-0.2656	0.3634	0.3334
24	-	-	0.1804	0.1774	-0.1166	0.1734	0.2274	-0.4556	0.0909	0.2584	0.4684	-0.4106	0.2884	0.2084
25.5	-	-	-0.0296	0.0674	-0.1916	0.0284	0.0774	-0.5706	0.0159	0.0134	0.3884	-0.5406	0.1384	0.1034
27	-	-	-0.2196	-0.0026	-0.2516	-0.0916	-0.0426	-0.5456	-0.0191	-0.1366	0.4084	-0.7306	-0.0516	-0.0316
28.5	-	-	-	-0.1276	-0.3816	-0.1916	-0.1826	-0.6106	-0.0541	-0.1916	0.1784	-0.9356	-0.1966	-0.2016
30	-	-	-	-0.2126	-0.4816	-0.3366	-0.3126	-0.6656	-0.1091	-0.1916	-0.0216	-	-0.3366	-0.3416
31.5	-	-	-	-	-0.6416	-	-0.4626	-	-0.1741	-0.2116	-0.2266	-	-0.7366	-0.5216
33	-	-	-	-	-0.7816	-	-	-	-0.3441	-0.5166	-0.4166	-	-1.1366	-0.7066
34.5	-	-	-	-	-1.0016	-	-	-	-0.5441	-0.8066	-	-	-	-0.8916
36	-	-	-	-	-	-	-	-	-0.8291	-0.9616	-	-	-	-

Table 4: Control Point 4 Historical Data

Control Point 4			Elevation	1.200	X	214135.02	Y	2354370						
X	1-Apr-14	8-Apr-14	16-Apr-14	22-Apr-14	29-Apr-14	6-May-14	13-May	20-May-14	27-May-14	11-Jun-14	26-Jun-14	13-Aug-14	27-Aug-14	10-Sept-14
0	1.1113	-	1.1123	1.1603	1.1303	1.1603	1.1553	1.1603	1.1653	1.1653	1.1753	1.2103	1.2103	1.2203
1.5	1.1568	-	1.3623	1.4003	1.3453	1.4103	1.4453	1.4003	1.5653	1.5453	1.5803	1.4853	1.5003	1.5003
3	0.7688	-	1.4043	1.4103	1.3103	1.4253	1.4913	1.4753	1.5153	1.5853	1.5203	1.5403	1.4903	1.5353
4.5	0.7328	-	1.3933	1.4003	1.3053	1.4153	1.4323	1.4053	1.4003	1.4253	1.4153	1.4303	1.4003	1.4253
6	0.6898	-	1.4013	1.3903	1.2903	1.4253	1.4123	1.3953	1.3903	1.4203	1.3953	1.4053	1.4003	1.4203
7.5	0.6498	-	1.3963	1.3803	1.2603	1.4153	1.4023	1.3653	1.2753	1.4053	1.3753	1.3853	1.3653	1.4103
9	0.6808	-	1.3383	1.3703	1.1953	1.3703	1.3623	1.3253	1.0028	1.3503	1.3253	1.3553	1.3353	1.3803
10.5	0.7258	-	1.3403	1.3653	1.2003	1.3903	1.3973	1.3553	1.0378	1.3553	1.3453	1.3453	1.3653	1.3603
12	0.5358	-	1.3223	1.3553	1.1703	1.3803	1.3723	1.3203	1.0028	1.3553	1.3403	1.3553	1.3153	1.3853
13.5	0.2838	-	1.2923	1.3503	1.1203	1.3503	1.3313	1.2803	0.9628	1.3003	1.3853	1.3153	1.2753	1.3353
15	0.0858	-	1.3023	1.3453	1.0703	1.3203	1.3213	1.2323	0.9228	1.2603	1.3703	1.2853	1.2553	1.3253
16.5	-0.1492	-	1.2903	1.3073	1.0103	1.2853	1.2413	0.4823	0.3378	1.1903	1.3053	1.2253	0.6553	1.1553
18	-0.3792	-	1.1753	1.1773	0.8953	0.3753	0.2663	0.0823	-0.1347	0.2903	0.3653	0.4153	0.1553	0.2953
19.5	-0.6242	-	1.0403	1.0073	0.7053	0.1403	0.1813	-0.0327	-0.2297	0.0853	0.0853	0.0503	-0.0497	-0.0147
21	-0.7792	-	0.8453	0.2223	-0.1147	0.0403	0.1703	-0.1502	-0.2572	0.0703	-0.0197	-0.0197	-0.0447	0.0353
22.5	-0.8892	-	0.6503	0.0673	-0.2297	-0.0147	0.1203	-	-0.2822	-0.1797	-0.1997	-0.1097	-0.0197	0.1053
24	-	-	0.4153	-0.0177	-0.2997	-0.0047	0.0403	-	-0.4772	-0.3097	-0.3897	-0.0597	-0.0447	-0.0397
25.5	-	-	-0.0997	-	-0.4297	-0.1647	-0.1697	-	-0.6672	-	-	-0.2297	-0.2747	-0.3847
27	-	-	-0.3097	-	-0.6247	-	-0.3097	-	-0.8772	-	-	-0.3847	-0.4447	-0.4947
28.5	-	-	-	-	-0.8547	-	-0.4197	-	-	-	-	-0.5547	-0.6147	-0.6647
30	-	-	-	-	-	-	-	-	-	-	-	-0.7597	-0.8547	-0.8147
31.5	-	-	-	-	-	-	-	-	-	-	-	-0.9147	-	-1.1047
33	-	-	-	-	-	-	-	-	-	-	-	-1.0697	-	-1.3947

Table 5: Control Point 5 Historical Data

Control Point 5			Elevation	1.844	X	214135.02	Y	2354370						
X	**1-Apr-14**	**8-Apr-14**	**16-Apr-14**	**22-Apr-14**	**29-Apr-14**	**6-May-14**	**13-May**	**20-May-14**	**27-May-14**	**11-Jun-14**	**26-Jun-14**	**13-Aug-14**	**27-Aug-14**	**10-Sept-14**
0	1.7824	-	1.8194	1.8094	1.7744	1.7744	1.7804	-	1.8094	1.7944	1.7994	1.8294	1.8294	1.8144
1.5	1.6574	-	1.6744	1.6794	1.6444	1.6444	1.6404	-	1.6644	1.6744	1.6644	1.6744	1.6694	1.6544
3	1.6574	-	1.6444	1.6494	1.6094	1.6094	1.6024	-	1.6144	1.6494	1.6244	1.6294	1.6194	1.6144
4.5	1.4274	-	1.4544	1.3474	1.3744	1.3544	1.2874	-	1.4344	1.4494	1.4244	1.3894	1.3694	1.3544
6	1.0024	-	1.0494	0.9874	1.1094	1.0444	0.9964	-	1.0369	1.0794	1.1094	1.0394	1.0694	1.0544
7.5	0.8274	-	0.8804	0.8224	0.9194	0.8694	0.8164	-	0.8594	0.8994	0.8744	0.8494	0.8894	0.8944
9	0.8224	-	0.8504	0.8024	0.8494	0.8194	0.7964	-	0.8444	0.8794	0.8394	0.8044	0.8394	0.8544
10.5	0.8374	-	0.8604	0.8274	0.8444	0.8694	0.7964	-	0.8444	0.9044	0.8594	0.8494	0.8594	0.8544
12	0.7834	-	0.8304	0.7874	0.7994	0.7994	0.7404	-	0.7994	0.8444	0.8194	0.7994	0.8144	0.7744
13.5	0.7614	-	0.8054	0.7524	0.7644	0.7644	0.7034	-	0.7694	0.8244	0.8044	0.7294	0.7144	0.6844
15	0.7014	-	0.7454	0.5024	0.5844	0.4994	0.3724	-	0.4544	0.5344	0.5894	0.4394	0.4244	0.3894
16.5	0.4944	-	0.3854	0.2724	0.3194	0.2594	0.1884	-	0.0644	0.1244	0.2794	0.1294	0.1244	0.1494
18	0.4244	-	0.2404	0.1024	0.0894	0.1094	0.0604	-	-0.0706	-0.0206	0.0044	-0.0456	-0.0456	-0.0856
19.5	0.2594	-	0.2004	-0.0226	-0.0606	0.0194	0.0624	-	-0.1306	-0.0806	-0.0806	-0.1056	-0.0556	-0.0256
21	-0.0626	-	0.0554	-0.1676	-	-0.1306	-0.0576	-	-0.1731	-0.1206	-0.0906	-0.0606	0.0144	0.0294
22.5	-0.3026	-	-0.1446	-0.2676	-	-0.1106	-0.0426	-	-0.1631	-0.0406	-0.0306	-0.0156	-0.0156	-0.1906
24	-0.4416	-	-	-	-	-0.2006	-0.0316	-	-0.0931	0.0394	0.0294	-0.1906	-0.2656	-0.3056
25.5	-0.5816	-	-	-	-	-0.3556	-0.2766	-	-0.1156	-0.0206	-0.1756	-0.3256	-0.3956	-0.4406
27	-	-	-	-	-	-	-0.4116	-	-0.3556	-0.2306	-0.4056	-0.4556	-0.5756	-0.6206
28.5	-	-	-	-	-	-	-	-	-0.5906	-0.3806	-0.6006	-0.6106	-0.5356	-0.8306
30	-	-	-	-	-	-	-	-	-0.7356	-	-	-0.7806	-	-1.0406
31.5	-	-	-	-	-	-	-	-	-	-	-	-0.9106	-	-
33	-	-	-	-	-	-	-	-	-	-	-	-1.0406	-	-

Table 6: Control Point 6 Historical Data

Control Point 6			Elevation	2.675	X	214135.02	Y	2354370						
X	1-Apr-14	8-Apr-14	16-Apr-14	22-Apr-14	29-Apr-14	6-May-14	13-May	20-May-14	27-May-14	11-Jun-14	26-Jun-14	13-Aug-14	27-Aug-14	10-Sept-14
0	1.9946	-	1.9746	2.0096	1.9546	1.9646	2.0096	1.9796	1.9746	1.9696	1.9596	1.9846	1.9746	1.9796
1.5	1.4511	-	1.8246	1.6846	1.6096	1.7046	1.6996	1.7296	1.7146	1.7546	1.7696	1.7496	1.6946	1.6896
3	0.8881	-	1.3046	1.2646	1.2396	1.2846	1.2696	1.3196	1.2871	1.3646	1.3346	1.3396	1.3546	1.3196
4.5	0.4349	-	1.0596	0.9896	0.9496	1.0946	1.0646	1.1116	1.0221	1.1696	1.1196	1.0646	1.0646	1.1146
6	0.1599	-	0.8496	0.7146	0.6696	0.8346	0.7746	0.7566	0.7646	0.8036	0.7096	0.7346	0.7146	0.7296
7.5	-0.0051	-	0.5996	0.4746	0.4546	0.5846	0.5146	0.5416	0.4746	0.5236	0.5096	0.3996	0.4096	0.4796
9	-0.2441	-	0.3696	0.1746	0.1246	0.2896	0.2286	0.1491	0.1371	0.2036	0.1146	0.1496	0.1396	0.0746
10.5	-0.3891	-	0.2596	-0.0994	-0.1654	0.0596	0.0326	-0.0234	-0.0329	0.0436	-0.0604	0.0796	0.0396	-0.0454
12	-0.6341	-	0.1696	-0.2444	-0.1454	-0.0354	-0.0634	-0.1684	-0.1329	0.0086	-0.0954	0.0096	-0.0204	-0.0954
13.5	-0.7691	-	0.0146	-0.3494	-0.2054	-0.1754	-0.0784	-0.2534	-0.2054	-0.1414	-0.2804	-0.0004	-0.0654	-0.1804
15	-0.8841	-	-0.1754	-	-0.4954	-0.2704	-0.1134	-0.3284	-0.1904	-0.3314	-0.4754	-0.1504	-0.1354	-0.1704
16.5	-0.9951	-	-0.3254	-	-	-	-0.1904	-	-0.1604	-0.5614	-0.7154	-0.3054	-0.0354	-0.1904
18	-1.0951	-	-	-	-	-	-0.2324	-	-0.2529	-0.7214	-0.8254	-0.4604	-0.2554	-0.1454
19.5	-	-	-	-	-	-	-0.2824	-	-0.2879	-	-	-0.5954	-0.4854	-0.3254
21	-	-	-	-	-	-	-0.3524	-	-0.4029	-	-	-0.7154	-0.6354	-0.3904
22.5	-	-	-	-	-	-	-0.4144	-	-0.5504	-	-	-0.7904	-	-0.4504
24	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.5454
25.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.6754
27	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.8304
28.5	-	-	-	-	-	-	-	-	-	-	-	-	-	-0.9854

Table 7: Control Point 1 Data 4/1/2014

Control Point 1				
4/1/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.34	1.4	0.06	1.7443
1.5	1.43	1.29	-0.14	1.8843
3	1.395	1.325	-0.07	1.9543
4.5	1.32	1.4	0.08	1.8743
6	1.26	1.465	0.205	1.6693
7.5	1.34	1.38	0.04	1.6293
9	1.285	1.435	0.15	1.4793
10.5	1.38	1.34	-0.04	1.5193
12	1.365	1.35	-0.015	1.5343
13.5	1.35	1.37	0.02	1.5143
15	1.36	1.36	0	1.5143
16.5	1.35	1.37	0.02	1.4943
18	1.38	1.335	-0.045	1.5393
19.5	1.335	1.38	0.045	1.4943
21	1.32	1.4	0.08	1.4143
22.5	1.42	1.3	-0.12	1.5343
24	0.76	1.8	1.04	0.4943
25.5	0.89	1.65	0.76	-0.2657
27	1.6	1.385	-0.215	-0.0507
28.5	1.2	1.4	0.2	-0.2507

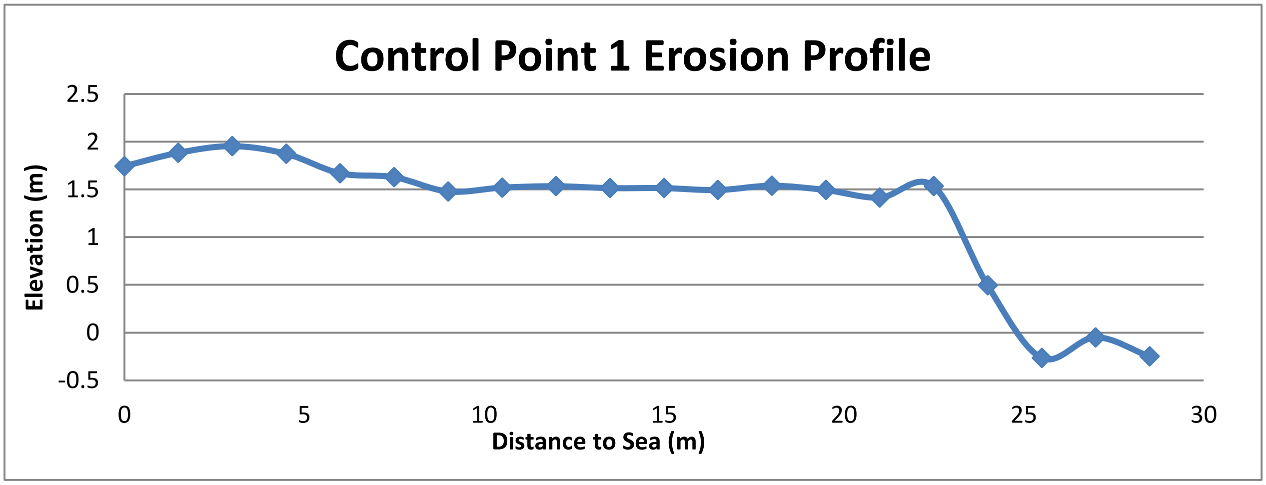

Figure 16: Control Point 1 Erosion Profile 4/1/2014

Table 8: Control Point 1 Data 4/16/2014

Control Point 1				
4/16/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.58	1.63	0.05	1.7543
1.5	1.675	1.525	-0.15	1.9043
3	1.65	1.565	-0.085	1.9893
4.5	1.55	1.64	0.09	1.8993
6	1.54	1.65	0.11	1.7893
7.5	1.535	1.655	0.12	1.6693
9	1.512	1.68	0.168	1.5013
10.5	1.605	1.58	-0.025	1.5263
12	1.61	1.575	-0.035	1.5613
13.5	1.675	1.61	-0.065	1.6263
15	1.6	1.59	-0.01	1.6363
16.5	1.57	1.63	0.06	1.5763
18	1.55	1.65	0.1	1.4763
19.5	1.53	1.67	0.14	1.3363
21	1.51	1.69	0.18	1.1563
22.5	1.49	1.71	0.22	0.9363
24	1.465	1.74	0.275	0.6613
25.5	1.38	1.84	0.46	0.2013
27	1.468	1.74	0.272	-0.0707
28.5	1.5	1.71	0.21	-0.2807

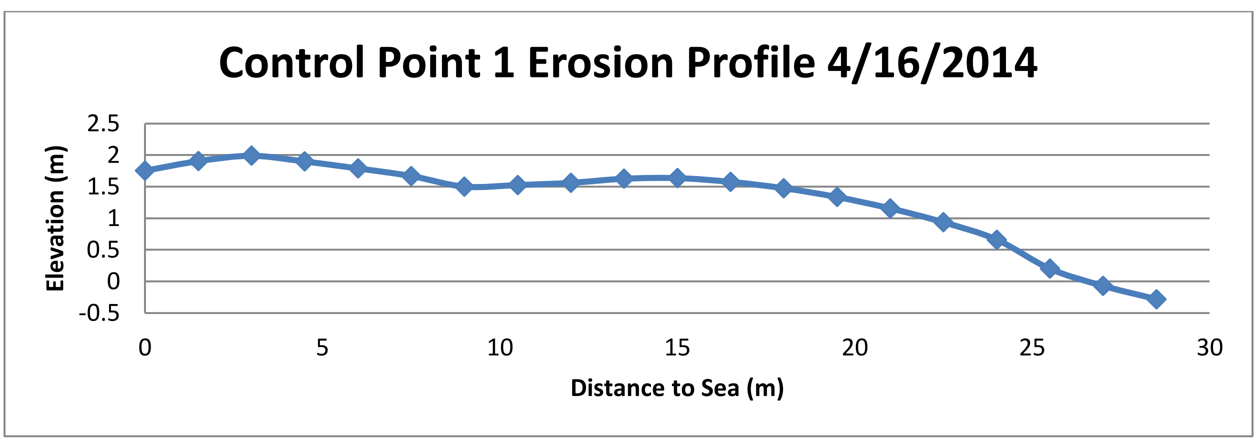

Figure 17: Control Point 1 Erosion Profile 4/16/2014

Table 9: Control Point 1 Data 4/22/2014

Control Point 1				
4/22/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.298	1.33	0.032	1.7723
1.5	1.378	1.245	-0.133	1.9053
3	1.36	1.28	-0.08	1.9853
4.5	1.28	1.355	0.075	1.9103
6	1.27	1.365	0.095	1.8153
7.5	1.205	1.42	0.215	1.6003
9	1.273	1.355	0.082	1.5183
10.5	1.33	1.3	-0.03	1.5483
12	1.309	1.325	0.016	1.5323
13.5	1.33	1.295	-0.035	1.5673
15	1.295	1.33	0.035	1.5323
16.5	1.265	1.36	0.095	1.4373
18	1.25	1.375	0.125	1.3123
19.5	1.22	1.4	0.18	1.1323
21	1.03	1.585	0.555	0.5773
22.5	1.09	1.535	0.445	0.1323
24	1.18	1.445	0.265	-0.1327
25.5	1.25	1.38	0.13	-0.2627

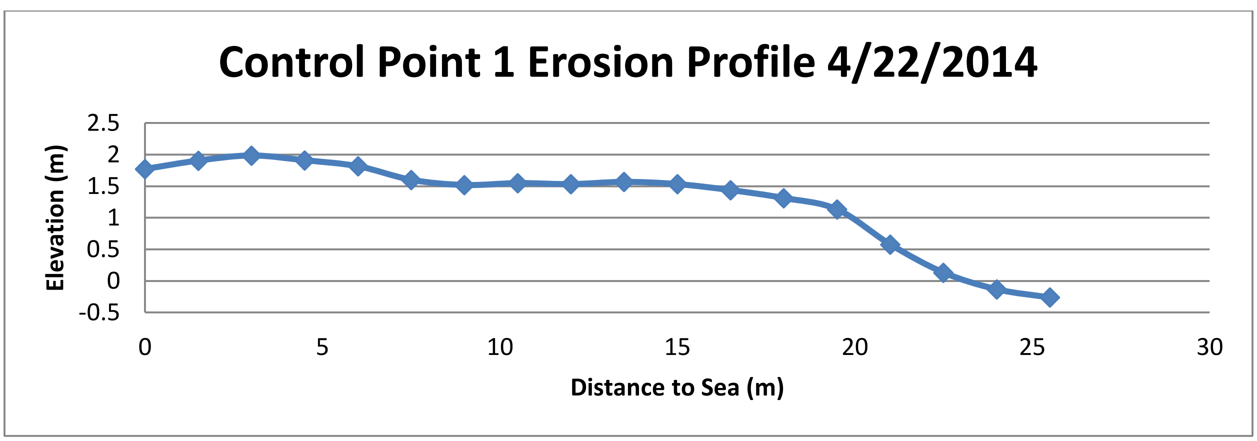

Figure 18: Control Point 1 Erosion Profile 4/22/2014

Table 10: Control Point 1 Data 4/29/2014

Control Point 1				
4/29/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.45	1.535	0.085	1.7193
1.5	1.54	1.45	-0.09	1.8093
3	1.52	1.465	-0.055	1.8643
4.5	1.435	1.55	0.115	1.7493
6	1.42	1.56	0.14	1.6093
7.5	1.4	1.59	0.19	1.4193
9	1.495	1.49	-0.005	1.4243
10.5	1.49	1.49	0	1.4243
12	1.465	1.52	0.055	1.3693
13.5	1.47	1.51	0.04	1.3293
15	1.45	1.53	0.08	1.2493
16.5	1.42	1.56	0.14	1.1093
18	1.405	1.58	0.175	0.9343
19.5	1.395	1.59	0.195	0.7393
21	0.895	1.955	1.06	-0.3207
22.5	1.285	1.565	0.28	-0.6007
24	1.295	1.56	0.265	-0.8657

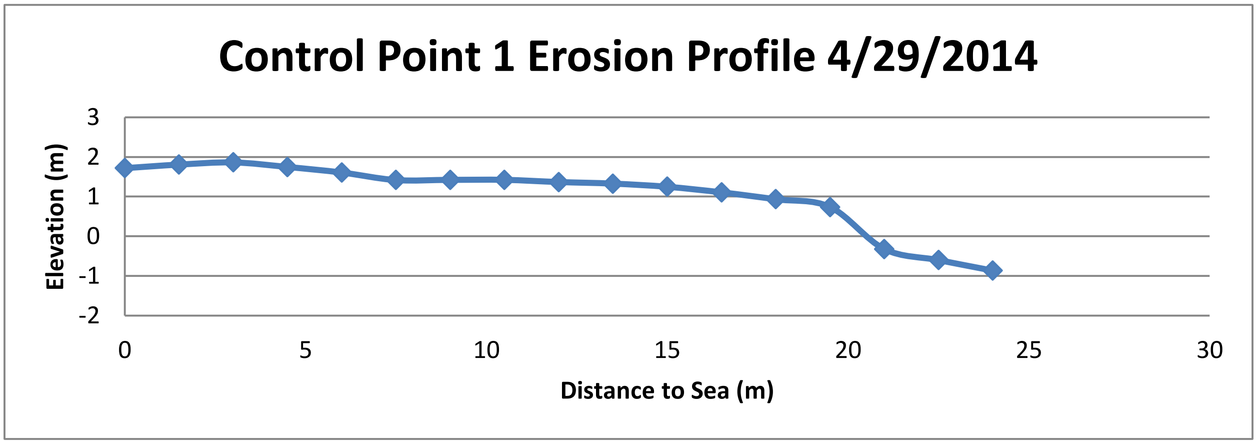

Figure 19: Control Point 1 Erosion Profile 4/29/2014

Table 11: Control Point 1 Data 5/6/2014

Control Point 1				
5/6/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.45	1.491	0.041	1.7633
1.5	1.532	1.41	-0.122	1.8853
3	1.515	1.425	-0.09	1.9753
4.5	1.43	1.57	0.14	1.8353
6	1.48	1.57	0.09	1.7453
7.5	1.44	1.62	0.18	1.5653
9	1.485	1.57	0.085	1.4803
10.5	1.545	1.51	-0.035	1.5153
12	1.54	1.51	-0.03	1.5453
13.5	1.523	1.525	0.002	1.5433
15	1.5	1.5	0	1.5433
16.5	1.48	1.57	0.09	1.4533
18	1.48	1.58	0.1	1.3533
19.5	1.45	1.61	0.16	1.1933
21	1.115	1.91	0.795	0.3983
22.5	1.385	1.68	0.295	0.1033
24	1.4	1.67	0.27	-0.1667
25.5	1.46	1.605	0.145	-0.3117

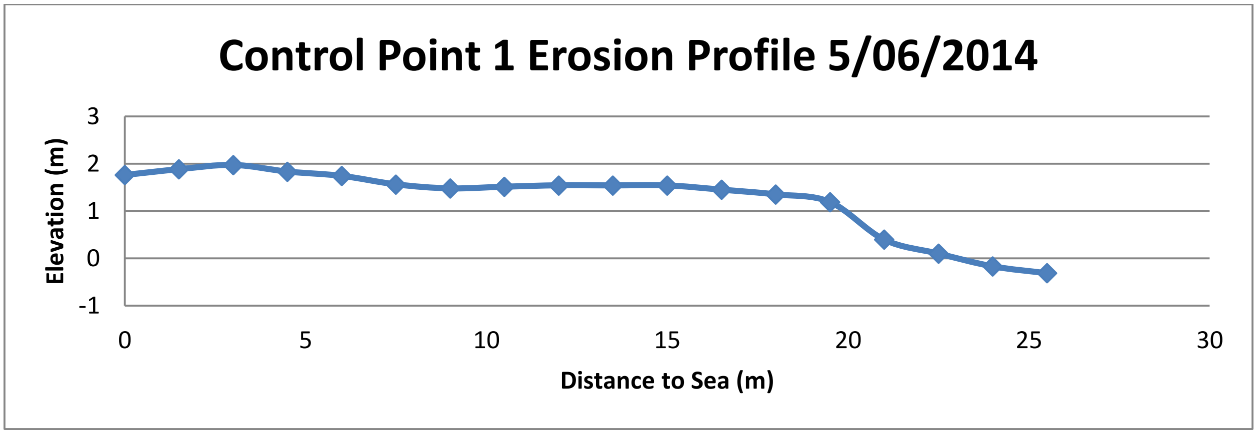

Figure 20: Control Point 1 Erosion Profile 5/06/2014

Table 12: Control Point 1 Data 5/20/2014

Control Point 1				
5/20/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.35	1.375	0.025	1.7793
1.5	1.42	1.3	-0.12	1.8993
3	1.395	1.325	-0.07	1.9693
4.5	1.32	1.395	0.075	1.8943
6	1.32	1.405	0.085	1.8093
7.5	1.28	1.44	0.16	1.6493
9	1.315	1.4	0.085	1.5643
10.5	1.37	1.35	-0.02	1.5843
12	1.375	1.345	-0.03	1.6143
13.5	1.355	1.365	0.01	1.6043
15	1.335	1.385	0.05	1.5543
16.5	1.33	1.39	0.06	1.4943
18	1.305	1.415	0.11	1.3843
19.5	0.63	1.925	1.295	0.0893
21	1.16	1.395	0.235	-0.1457
22.5	1.2	1.35	0.15	-0.2957

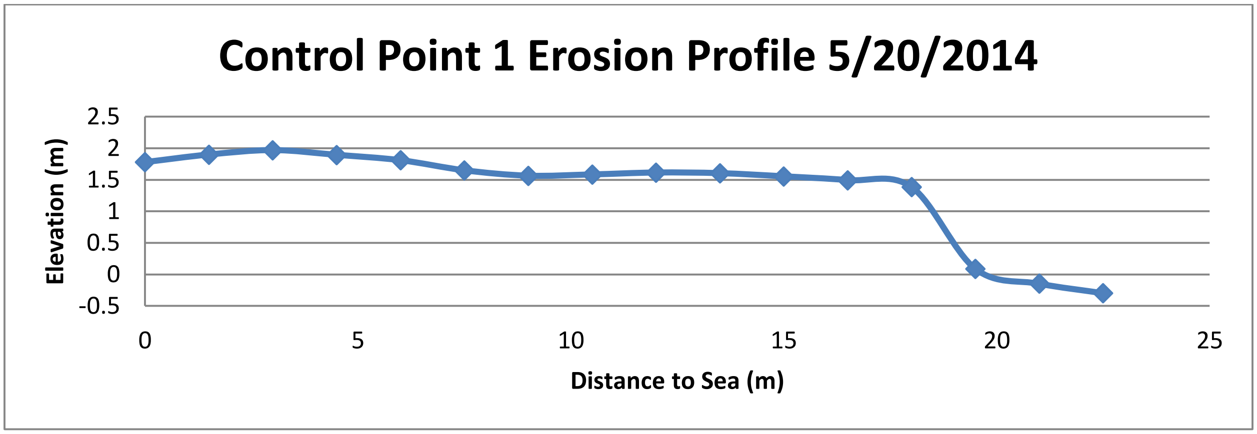

Figure 21: Control Point 1 Erosion Profile 5/20/2014

Table 13: Control Point 1 Data 5/27/2014

Control Point 1				
5/27/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.39	1.42	0.03	1.7743
1.5	1.46	1.35	-0.11	1.8843
3	1.44	1.37	-0.07	1.9543
4.5	1.36	1.445	0.085	1.8693
6	1.36	1.45	0.09	1.7793
7.5	1.32	1.485	0.165	1.6143
9	1.35	1.46	0.11	1.5043
10.5	1.485	1.37	-0.115	1.6193
12	1.4	1.41	0.01	1.6093
13.5	1.4	1.41	0.01	1.5993
15	1.385	1.425	0.04	1.5593
16.5	1.365	1.44	0.075	1.4843
18	0.625	1.725	1.1	0.3843
19.5	1.16	1.7	0.54	-0.1557
21	1.32	1.545	0.225	-0.3807
22.5	1.325	1.54	0.215	-0.5957

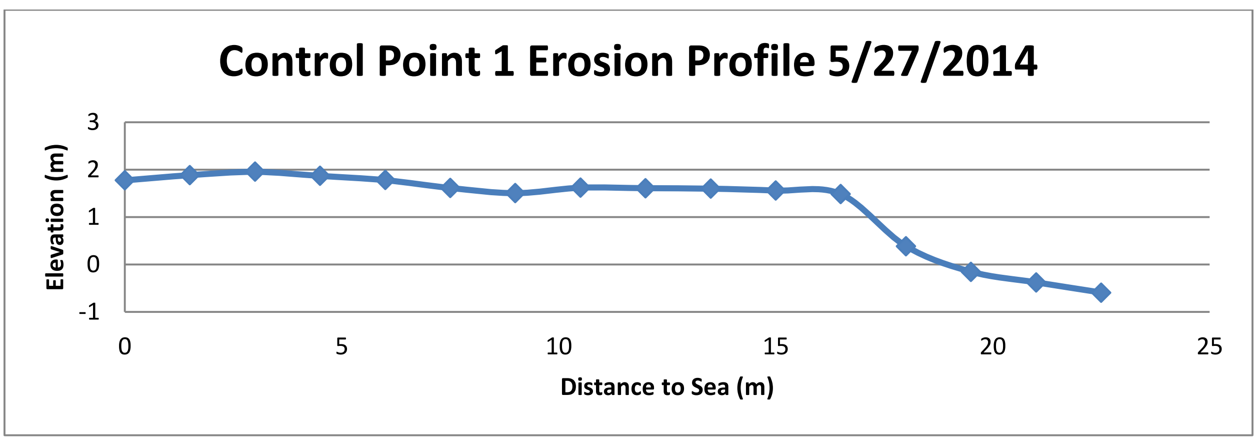

Figure 22: Control Point 1 Erosion Profile 5/27/2014

Table 14: Control Point 1 Data 6/11/2014

Control Point 1				
6/11/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.38	1.41	0.03	1.7743
1.5	1.445	1.34	-0.105	1.8793
3	1.44	1.345	-0.095	1.9743
4.5	1.35	1.435	0.085	1.8893
6	1.34	1.44	0.1	1.7893
7.5	1.34	1.44	0.1	1.6893
9	1.305	1.475	0.17	1.5193
10.5	1.38	1.4	0.02	1.4993
12	1.415	1.365	-0.05	1.5493
13.5	1.38	1.4	0.02	1.5293
15	1.385	1.39	0.005	1.5243
16.5	1.36	1.42	0.06	1.4643
18	1.34	1.445	0.105	1.3593
19.5	1.2	1.49	0.29	1.0693
21	0.48	1.952	1.472	-0.4027
22.5	1.115	1.32	0.205	-0.6077
24	1.09	1.35	0.26	-0.8677
25.5	1.17	1.26	0.09	-0.9577

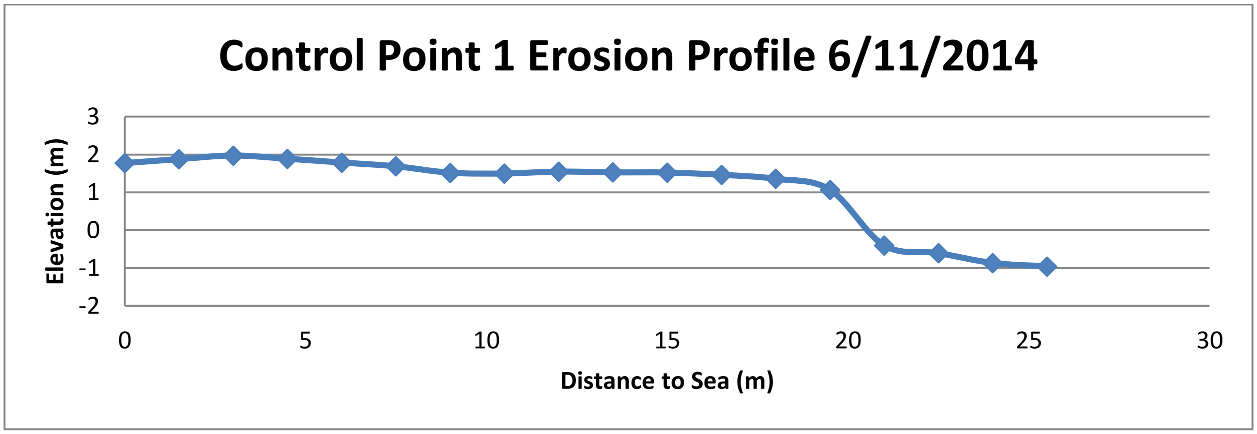

Figure 23: Control Point 1 Erosion Profile 6/11/2014

Table 15: Control Point 1 Data 6/26/2014

Control Point 1				
6/26/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.4	1.43	0.03	1.7743
1.5	1.45	1.38	-0.07	1.8443
3	1.465	1.37	-0.095	1.9393
4.5	1.37	1.46	0.09	1.8493
6	1.38	1.455	0.075	1.7743
7.5	1.355	1.495	0.14	1.6343
9	1.35	1.485	0.135	1.4993
10.5	1.405	1.425	0.02	1.4793
12	1.45	1.38	-0.07	1.5493
13.5	1.4	1.43	0.03	1.5193
15	1.405	1.425	0.02	1.4993
16.5	1.385	1.445	0.06	1.4393
18	1.05	1.76	0.71	0.7293
19.5	1.084	1.97	0.886	-0.1567
21	1.3	1.55	0.25	-0.4067

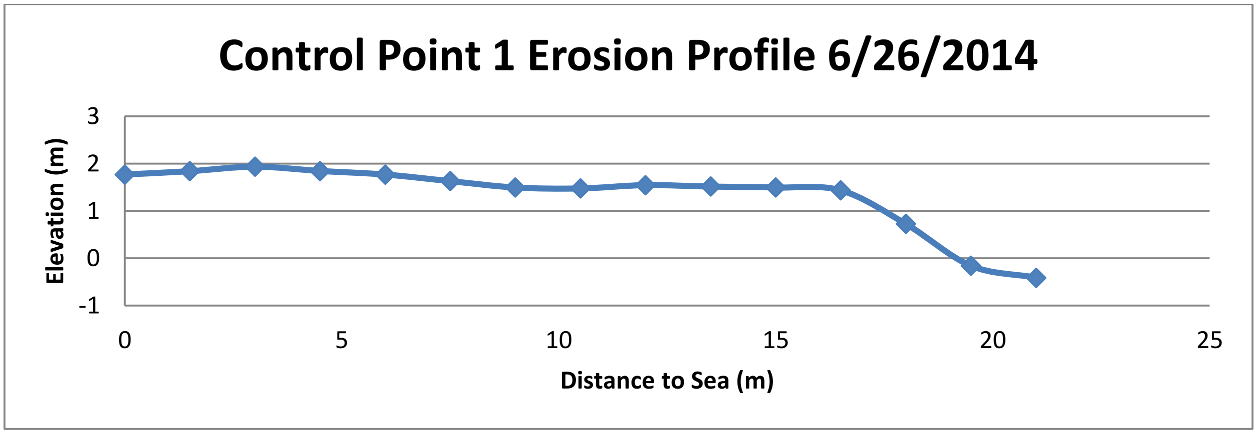

Figure 24: Control Point 1 Erosion Profile 6/26/2014

Table 16: Control Point 1 Data 8/13/2014

Control Point 1				
8/13/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.315	1.445	0.13	1.6743
1.5	1.3	1.45	0.15	1.5243
3	1.29	1.47	0.18	1.3443
4.5	1.295	1.46	0.165	1.1793
6	1.355	1.4	0.045	1.1343
7.5	1.382	1.37	-0.012	1.1463
9	1.395	1.36	-0.035	1.1813
10.5	1.395	1.36	-0.035	1.2163
12	1.365	1.39	0.025	1.1913
13.5	1.33	1.43	0.1	1.0913
15	1.29	1.47	0.18	0.9113
16.5	1.35	1.405	0.055	0.8563
18	1.32	1.44	0.12	0.7363
19.5	1.42	1.34	-0.08	0.8163

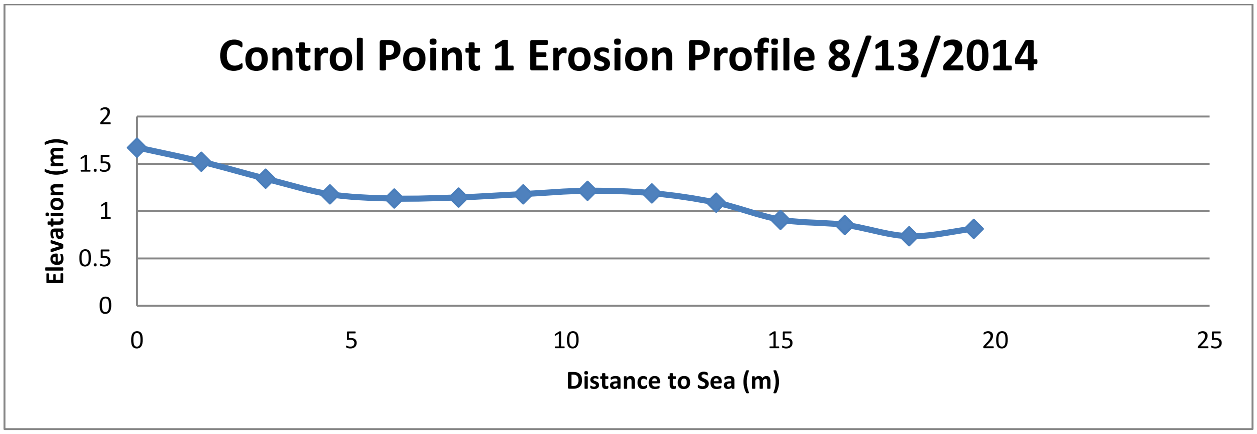

Figure 25: Control Point 1 Erosion Profile 8/13/2014

Table 17: Control Point 1 Data 8/27/2014

Control Point 1					
8/27/2014					
x	214723.9073				
y	2354495.891				
z	1.8043				
	Profile A (m)		Processed Data (m)		
X	Land	Sea	Differential	Final Value	
0	1.435	1.45	0.015	1.7893	
1.5	1.505	1.4	-0.105	1.8943	
3	1.49	1.42	-0.07	1.9643	
4.5	1.41	1.475	0.065	1.8993	
6	1.4	1.49	0.09	1.8093	
7.5	1.38	1.51	0.13	1.6793	
9	1.36	1.54	0.18	1.4993	
10.5	1.43	1.45	0.02	1.4793	
12	1.48	1.41	-0.07	1.5493	
13.5	1.435	1.45	0.015	1.5343	
15	1.445	1.445	0	1.5343	
16.5	1.405	1.48	0.075	1.4593	
18	0.59	1.895	1.305	0.1543	
19.5	1.04	1.45	0.41	-0.2557	
21	1.25	1.29	0.04	-0.2957	
22.5	1.175	1.31	0.135	-0.4307	
24	1.16	1.32	0.16	-0.5907	
25.5	1.17	1.32	0.15	-0.7407	
27	1.08	1.4	0.32	-1.0607	

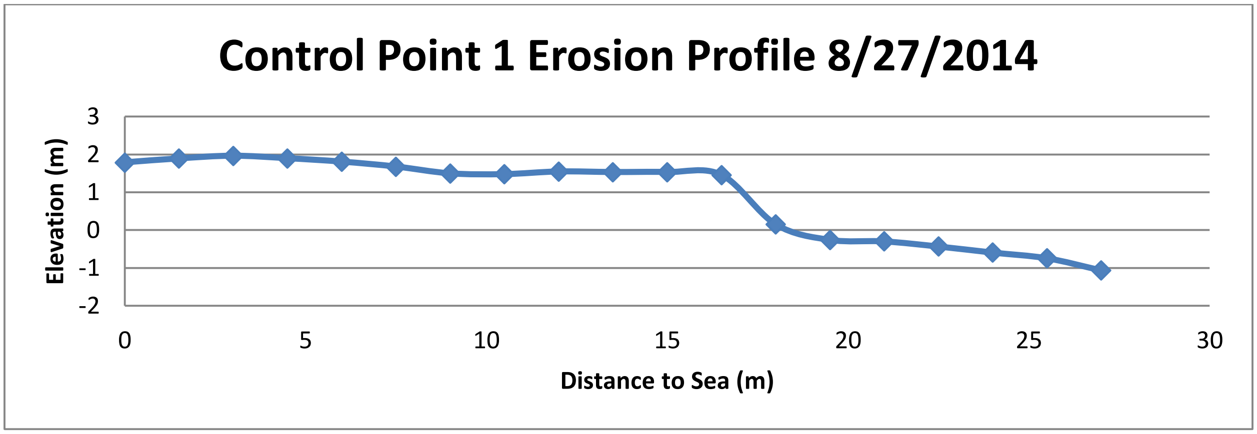

Figure 26: Control Point 1 Erosion Profile 8/27/2014

Table 18: Control Point 1 Data 9/10/2014

Control Point 1				
9/10/2014				
x	214723.9073			
y	2354495.891			
z	1.8043			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.37	1.4	0.03	1.7743
1.5	1.45	1.33	-0.12	1.8943
3	1.425	1.36	-0.065	1.9593
4.5	1.35	1.43	0.08	1.8793
6	1.33	1.45	0.12	1.7593
7.5	1.325	1.45	0.125	1.6343
9	1.305	1.48	0.175	1.4593
10.5	1.37	1.4	0.03	1.4293
12	1.43	1.34	-0.09	1.5193
13.5	1.37	1.41	0.04	1.4793
15	1.37	1.41	0.04	1.4393
16.5	1.33	1.45	0.12	1.3193
18	0.77	2.04	1.27	0.0493
19.5	1.215	1.56	0.345	-0.2957
21	1.315	1.46	0.145	-0.4407
22.5	1.29	1.49	0.2	-0.6407
24	1.28	1.5	0.22	-0.8607

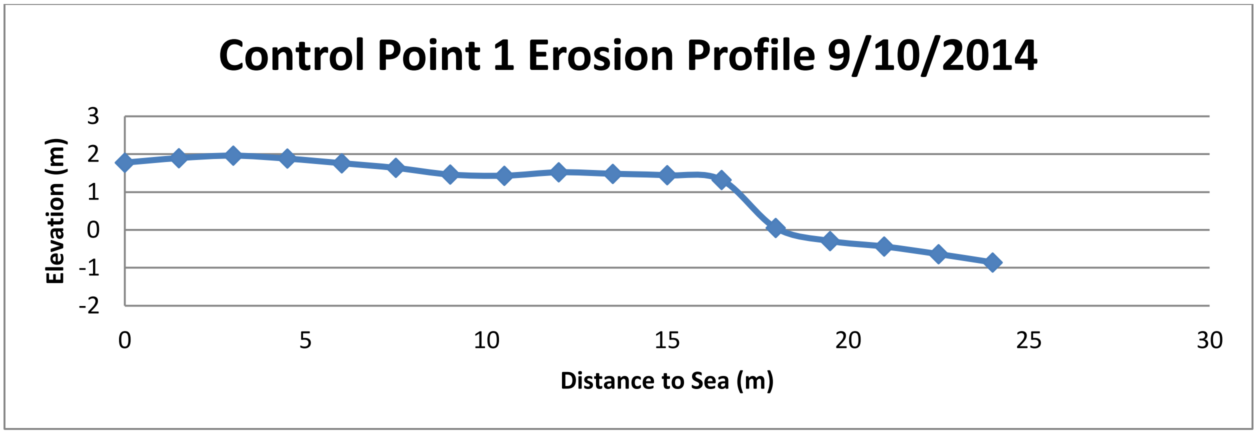

Figure 27: Control Point 1 Erosion Profile 9/10/2014

Table 19: Control Point 2 Data 4/1/2014

Control Point 2				
4/1/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.47	1.605	0.135	1.2573
1.5	1.519	1.555	0.036	1.2213
3	1.54	1.53	-0.01	1.2313
4.5	1.519	1.55	0.031	1.2003
6	1.54	1.53	-0.01	1.2103
7.5	1.529	1.54	0.011	1.1993
9	1.539	1.53	-0.009	1.2083
10.5	1.615	1.455	-0.16	1.3683
12	1.546	1.525	-0.021	1.3893
13.5	1.717	1.45	-0.267	1.6563
15	1.52	1.55	0.03	1.6263
16.5	0.45	1.71	1.26	0.3663
18	0.96	1.2	0.24	0.1263
19.5	0.97	1.205	0.235	-0.1087
21	0.995	1.2	0.205	-0.3137

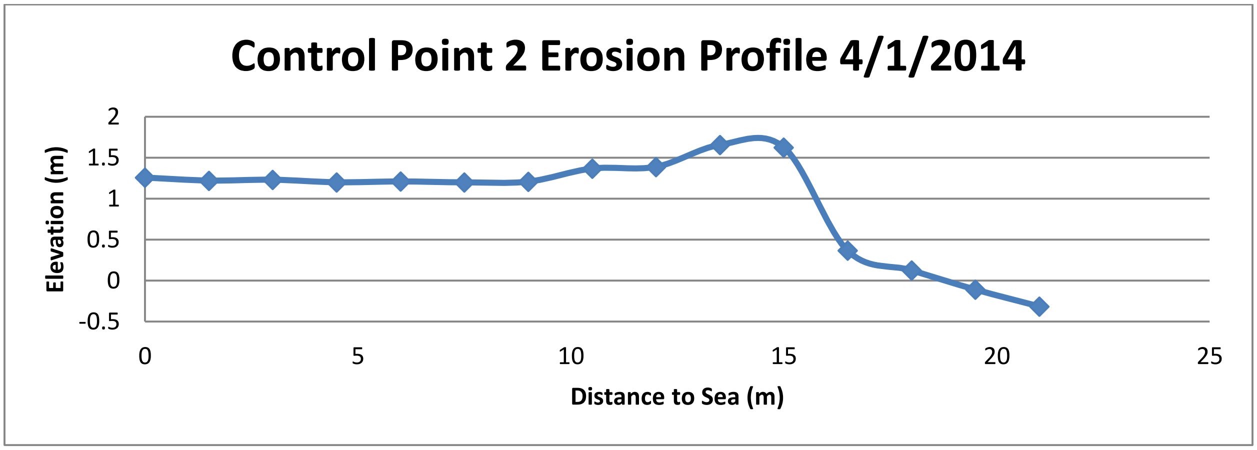

Figure 28: Control Point 2 Erosion Profile 4/1/2014

Table 20: Control Point 2 Data 4/16/2014

Control Point 2				
4/16/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.54	1.67	0.13	1.2623
1.5	1.58	1.63	0.05	1.2123
3	1.6	1.605	0.005	1.2073
4.5	1.605	1.6	-0.005	1.2123
6	1.595	1.61	0.015	1.1973
7.5	1.578	1.63	0.052	1.1453
9	1.6	1.61	0.01	1.1353
10.5	1.582	1.625	0.043	1.0923
12	1.565	1.645	0.08	1.0123
13.5	1.518	1.69	0.172	0.8403
15	1.472	1.74	0.268	0.5723
16.5	1.45	1.76	0.31	0.2623
18	1.588	1.72	0.132	0.1303
19.5	1.505	1.71	0.205	-0.0747
21	1.51	1.69	0.18	-0.2547

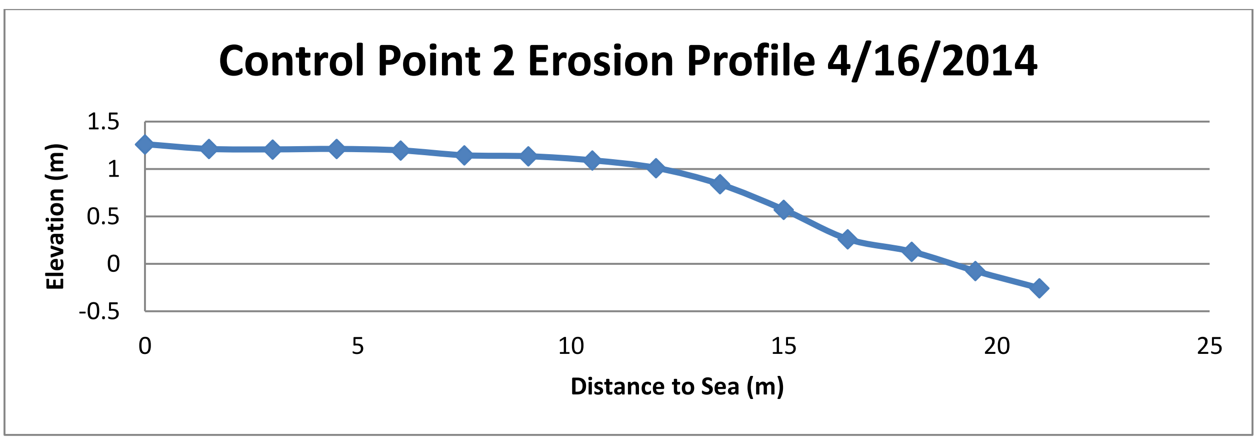

Figure 29: Control Point 2 Erosion Profile 4/16/2014

Table 21: Control Point 2 Data /22/2014

Control Point 2				
4/22/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.25	1.38	0.13	1.2623
1.5	1.295	1.34	0.045	1.2173
3	1.325	1.32	-0.005	1.2223
4.5	1.32	1.33	0.01	1.2123
6	1.31	1.33	0.02	1.1923
7.5	1.3	1.33	0.03	1.1623
9	1.31	1.328	0.018	1.1443
10.5	1.305	1.342	0.037	1.1073
12	1.26	1.275	0.015	1.0923
13.5	1.2	1.44	0.24	0.8523
15	1.08	1.555	0.475	0.3773
16.5	1.235	1.405	0.17	0.2073
18	1.275	1.365	0.09	0.1173
19.5	1.275	1.36	0.085	0.0323

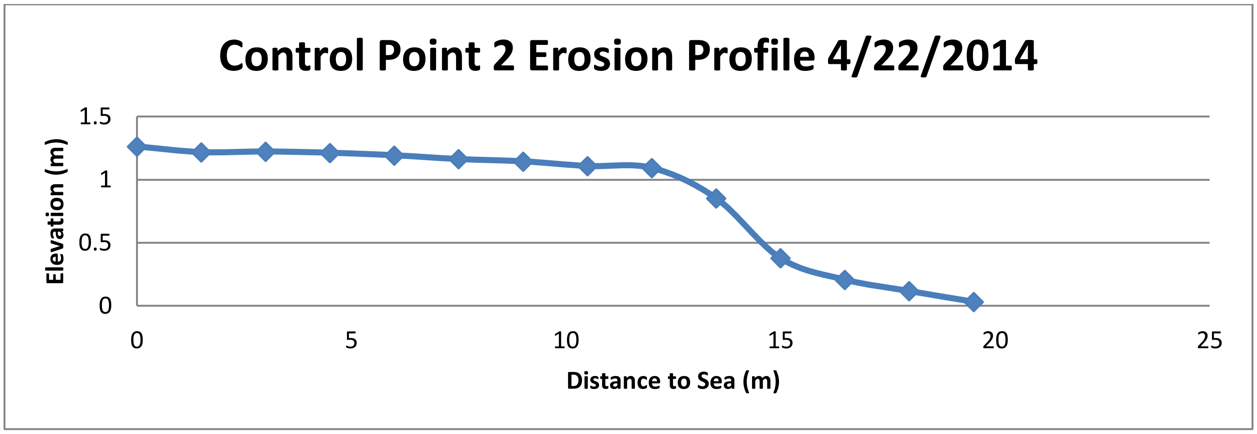

Figure 30: Control Point 2 Erosion Profile 4/22/2014

Table 22: Control Point 2 Data 4/29/2014

Control Point 2				
4/29/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.35	1.4	0.05	1.3423
1.5	1.39	1.45	0.06	1.2823
3	1.4	1.44	0.04	1.2423
4.5	1.41	1.43	0.02	1.2223
6	1.405	1.44	0.035	1.1873
7.5	1.39	1.455	0.065	1.1223
9	1.41	1.43	0.02	1.1023
10.5	1.395	1.45	0.055	1.0473
12	1.365	1.475	0.11	0.9373
13.5	1.32	1.52	0.2	0.7373
15	1.145	1.7	0.555	0.1823
16.5	1.31	1.53	0.22	-0.0377
18	1.34	1.5	0.16	-0.1977
19.5	1.34	1.505	0.165	-0.3627
21	1.35	1.5	0.15	-0.5127

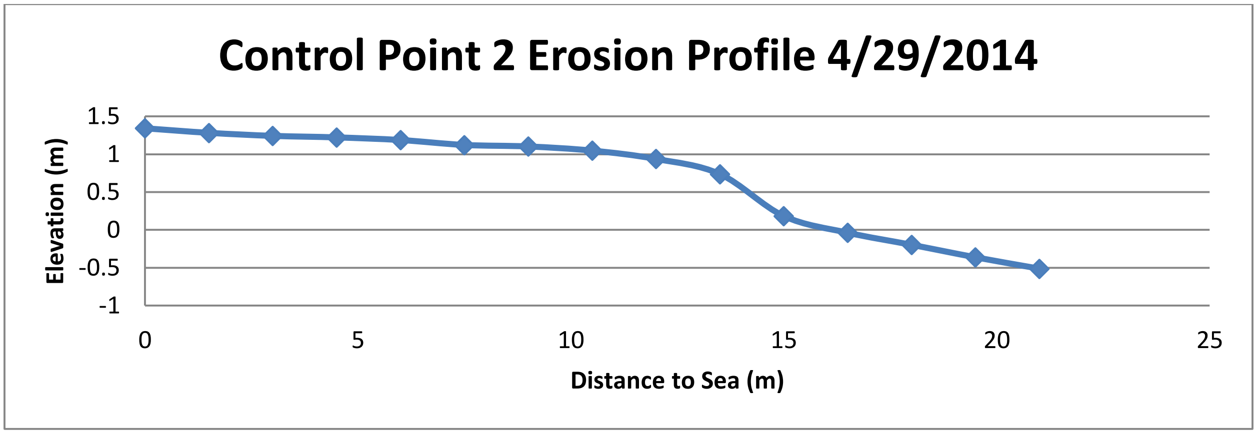

Figure 31: Control Point 2 Erosion Profile 4/29/2014

Table 23: Control Point Data 5/6/2014

Control Point 2				
5/6/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.47	1.6	0.13	1.2623
1.5	1.51	1.55	0.04	1.2223
3	1.53	1.53	0	1.2223
4.5	1.53	1.5	-0.03	1.2523
6	1.52	1.54	0.02	1.2323
7.5	1.51	1.55	0.04	1.1923
9	1.525	1.53	0.005	1.1873
10.5	1.51	1.545	0.035	1.1523
12	1.475	1.585	0.11	1.0423
13.5	1.25	1.81	0.56	0.4823
15	1.42	1.645	0.225	0.2573
16.5	1.45	1.61	0.16	0.0973
18	1.5	1.56	0.06	0.0373
19.5	1.49	1.57	0.08	-0.0427

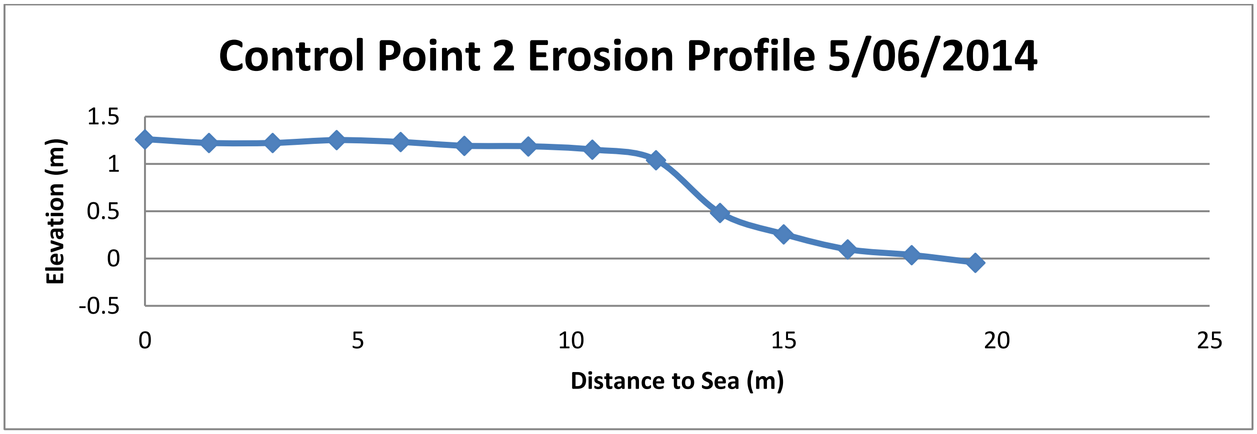

Figure 32: Control Point 2 Erosion Profile 5/06/2014

Table 24: Control Point 2 Data 5/20/2014

Control Point 2				
5/20/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.21	1.34	0.13	1.2623
1.5	1.265	1.29	0.025	1.2373
3	1.275	1.28	0.005	1.2323
4.5	1.28	1.28	0	1.2323
6	1.27	1.285	0.015	1.2173
7.5	1.26	1.3	0.04	1.1773
9	1.28	1.285	0.005	1.1723
10.5	1.26	1.295	0.035	1.1373
12	1.275	1.34	0.065	1.0723
13.5	0.88	1.67	0.79	0.2823
15	1.21	1.345	0.135	0.1473
16.5	1.225	1.335	0.11	0.0373
18	1.235	1.35	0.115	-0.0777

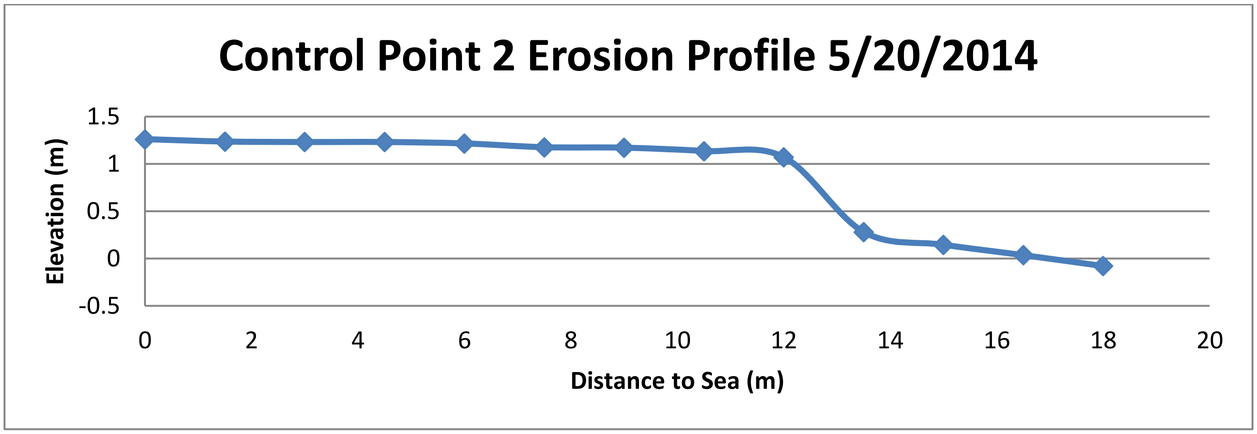

Figure 33: Control Point 2 Erosion Profile 5/20/2014

Table 25: Control Point 2 Data 5/27/2014

Control Point 2				
5/27/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.37	1.4975	0.1275	1.2648
1.5	1.42	1.445	0.025	1.2398
3	1.4225	1.445	0.0225	1.2173
4.5	1.425	1.4	-0.025	1.2423
6	1.425	1.44	0.015	1.2273
7.5	1.415	1.45	0.035	1.1923
9	1.425	1.44	0.015	1.1773
10.5	1.415	1.45	0.035	1.1423
12	1.28	1.59	0.31	0.8323
13.5	1.115	1.75	0.635	0.1973
15	1.3875	1.48	0.0925	0.1048
16.5	1.4175	1.45	0.0325	0.0723
18	1.415	1.45	0.035	0.0373
19.5	1.425	1.445	0.02	0.0173
21	1.44	1.425	-0.015	0.0323
22.5	1.41	1.455	0.045	-0.0127
24	1.3575	1.51	0.1525	-0.1652
25.5	1.33	1.54	0.21	-0.3752
27	1.32	1.545	0.225	-0.6002

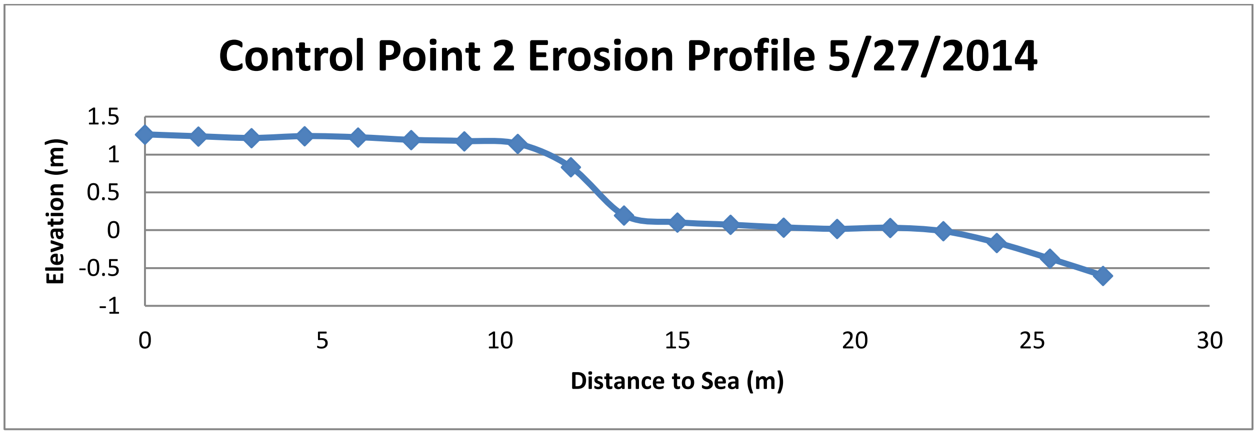

Figure 34: Control Point 2 Erosion Profile 5/27/2014

Table 26: Control Point 2 Data 6/11/2014

Control Point 2				
6/11/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.15	1.28	0.13	1.2623
1.5	1.205	1.22	0.015	1.2473
3	1.2	1.225	0.025	1.2223
4.5	1.21	1.215	0.005	1.2173
6	1.205	1.22	0.015	1.2023
7.5	1.19	1.24	0.05	1.1523
9	1.215	1.21	-0.005	1.1573
10.5	1.19	1.235	0.045	1.1123
12	1.16	1.265	0.105	1.0073
13.5	1.11	1.315	0.205	0.8023
15	1.18	1.255	0.075	0.7273
16.5	1.21	1.22	0.01	0.7173
18	1.21	1.225	0.015	0.7023
19.5	1.23	1.2	-0.03	0.7323
21	1.235	1.19	-0.045	0.7773
22.5	1.119	1.235	0.116	0.6613
24	1.205	1.22	0.015	0.6463
25.5	1.19	1.23	0.04	0.6063
27	1.13	1.3	0.17	0.4363
28.5	1.14	1.295	0.155	0.2813
30	1.08	1.35	0.27	0.0113

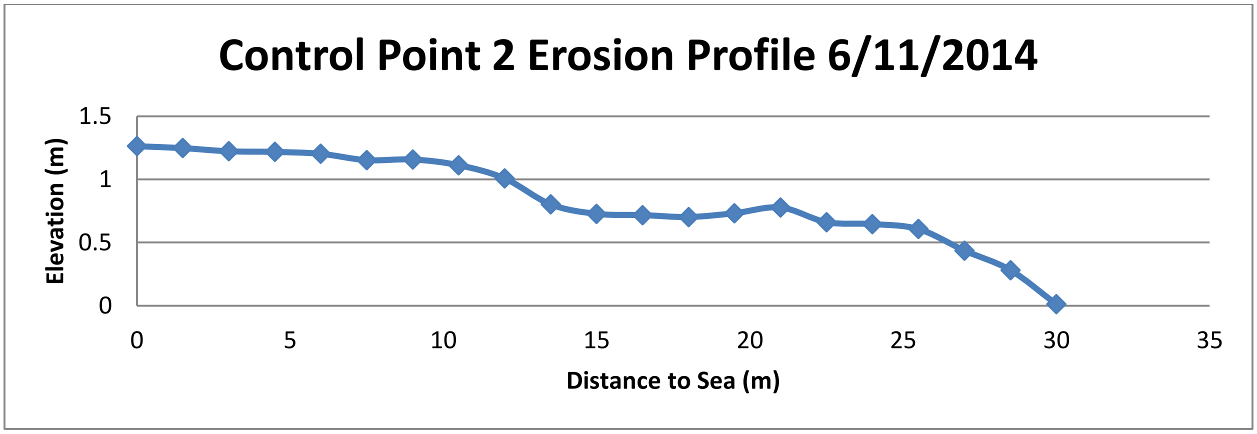

Figure 35: Control Point 2 Erosion Profile 6/11/2014

Table 27: Control Point 2 Data 6/26/2014

Control Point 2				
6/26/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.36	1.49	0.13	1.2623
1.5	1.41	1.43	0.02	1.2423
3	1.41	1.435	0.025	1.2173
4.5	1.42	1.425	0.005	1.2123
6	1.415	1.43	0.015	1.1973
7.5	1.4	1.445	0.045	1.1523
9	1.415	1.43	0.015	1.1373
10.5	1.4	1.433	0.033	1.1043
12	1.375	1.478	0.103	1.0013
13.5	1.06	1.79	0.73	0.2713
15	1.31	1.55	0.24	0.0313
16.5	1.385	1.455	0.07	-0.0387
18	1.42	1.42	0	-0.0387
19.5	1.41	1.43	0.02	-0.0587
21	1.43	1.41	-0.02	-0.0387
22.5	1.49	1.4	-0.09	0.0513
24	1.435	1.405	-0.03	0.0813
25.5	1.445	1.395	-0.05	0.1313
27	1.33	1.51	0.18	-0.0487
28.5	1.34	1.505	0.165	-0.2137
30	1.34	1.505	0.165	-0.3787

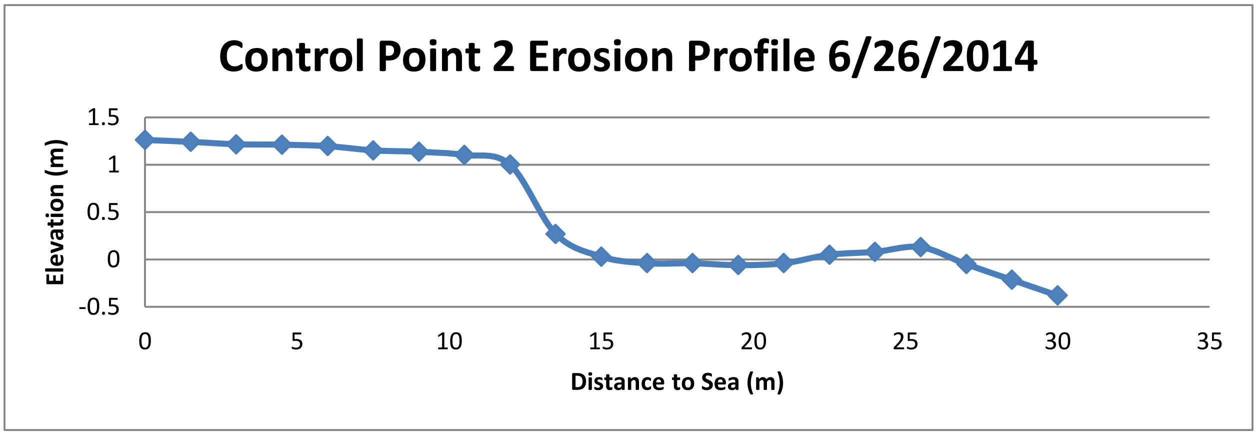

Figure 36: Control Point 2 Erosion Profile 6/26/2014

Table 28: Control Point 2 Data 8/13/2014

Control Point 2				
8/13/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.32	1.49	0.17	1.2223
1.5	1.38	1.43	0.05	1.1723
3	1.39	1.44	0.05	1.1223
4.5	1.395	1.42	0.025	1.0973
6	1.39	1.43	0.04	1.0573
7.5	1.37	1.45	0.08	0.9773
9	1.39	1.43	0.04	0.9373
10.5	1.37	1.44	0.07	0.8673
12	1.22	1.59	0.37	0.4973
13.5	1.16	1.66	0.5	-0.0027
15	1.285	1.53	0.245	-0.2477
16.5	1.34	1.41	0.07	-0.3177
18	1.365	1.39	0.025	-0.3427
19.5	1.375	1.38	0.005	-0.3477
21	1.385	1.36	-0.025	-0.3227
22.5	1.385	1.365	-0.02	-0.3027
24	1.28	1.48	0.2	-0.5027

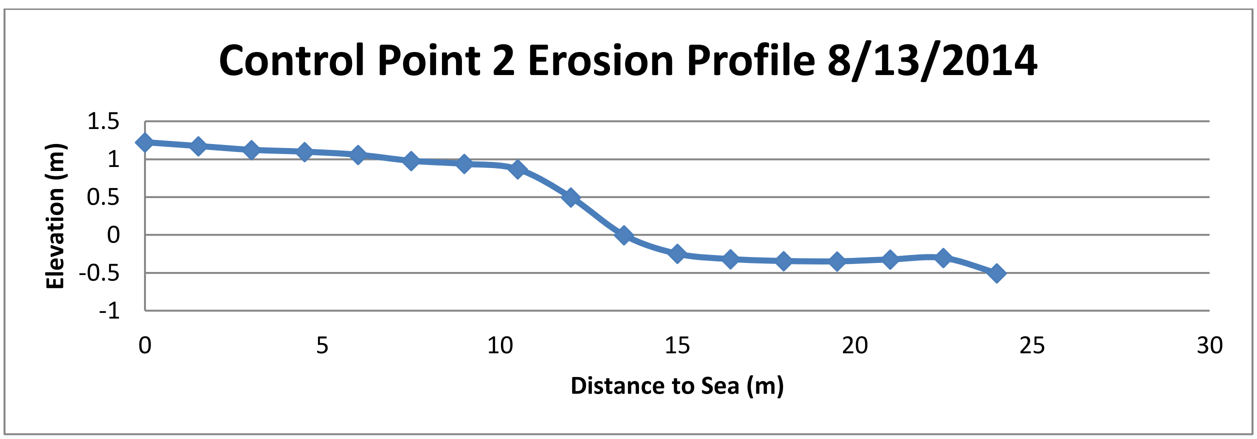

Figure 37: Control Point 2 Erosion Profile 8/13/2014

Table 29: Control Point 2 Data 8/27/2014

Control Point 2				
8/27/201				
x	214522.1674			
y	2354462.365			
z	1.3923			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.37	1.51	0.14	1.2523
1.5	1.43	1.45	0.02	1.2323
3	1.44	1.46	0.02	1.2123
4.5	1.445	1.44	-0.005	1.2173
6	1.44	1.45	0.01	1.2073
7.5	1.42	1.47	0.05	1.1573
9	1.44	1.45	0.01	1.1473
10.5	1.42	1.46	0.04	1.1073
12	1.27	1.61	0.34	0.7673
13.5	1.21	1.68	0.47	0.2973
15	1.335	1.55	0.215	0.0823
16.5	1.415	1.48	0.065	0.0173
18	1.42	1.47	0.05	-0.0327
19.5	1.46	1.43	-0.03	-0.0027
21	1.455	1.44	-0.015	0.0123
22.5	1.465	1.42	-0.045	0.0573
24	1.48	1.41	-0.07	0.1273
25.5	1.345	1.54	0.195	-0.0677
27	1.3	1.37	0.07	-0.1377
28.5	1.36	1.53	0.17	-0.3077
30	1.37	1.51	0.14	-0.4477
31.5	1.34	1.56	0.22	-0.6677

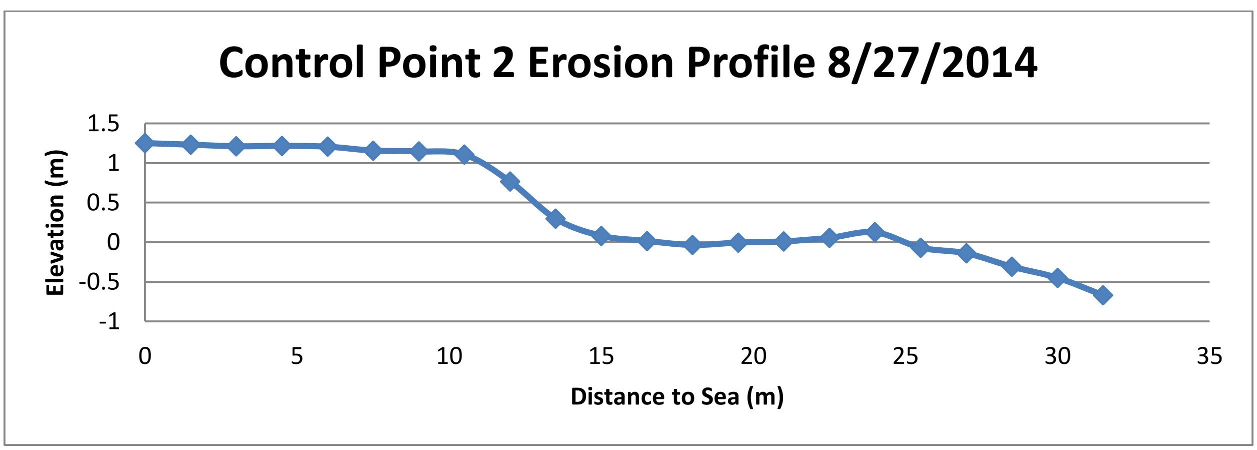

Figure 38: Control Point 2 Erosion Profile 8/27/2014

Table 30: Control Point 2 Data 9/10/2014

Control Point 2				
9/10/2014				
x	214522.1674			
y	2354462.365			
z	1.3923			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.32	1.455	0.135	1.2573
1.5	1.375	1.4	0.025	1.2323
3	1.375	1.4	0.025	1.2073
4.5	1.385	1.39	0.005	1.2023
6	1.38	1.4	0.02	1.1823
7.5	1.365	1.405	0.04	1.1423
9	1.38	1.39	0.01	1.1323
10.5	1.37	1.41	0.04	1.0923
12	1.25	1.53	0.28	0.8123
13.5	1.175	1.61	0.435	0.3773
15	1.24	1.54	0.3	0.0773
16.5	1.345	1.42	0.075	0.0023
18	1.37	1.4	0.03	-0.0277
19.5	1.405	1.37	-0.035	0.0073
21	1.34	1.43	0.09	-0.0827
22.5	1.315	1.47	0.155	-0.2377
24	1.31	1.475	0.165	-0.4027
25.5	1.3	1.49	0.19	-0.5927
27	1.3	1.49	0.19	-0.7827

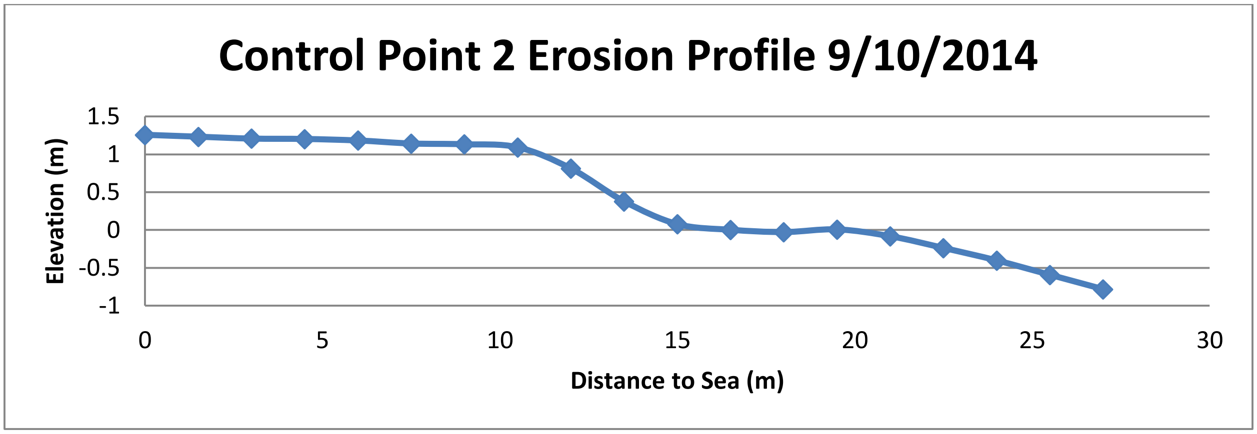

Figure 39: Control Point 2 Erosion Profile 9/10/2014

Table 31: Control Point 3 Data 4/1/2014

Control Point 3				
4/1/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.048	1.125	0.077	1.0914
1.5	1.09	1	-0.09	1.1814
3	1.105	1.08	-0.025	1.2064
4.5	1.087	1.1	0.013	1.1934
6	1.115	1.065	-0.05	1.2434
7.5	1.092	1.09	-0.002	1.2454
9	1.082	1.1	0.018	1.2274
10.5	1.072	1.11	0.038	1.1894
12	1.109	1.07	-0.039	1.2284
13.5	1.075	1.0057	-0.0693	1.2977
15	1.341	0.85	-0.491	1.7887
16.5	1.29	1.875	0.585	1.2037
18	0.685	1.486	0.801	0.4027
19.5	0.825	1.34	0.515	-0.1123
21	0.972	1.2	0.228	-0.3403

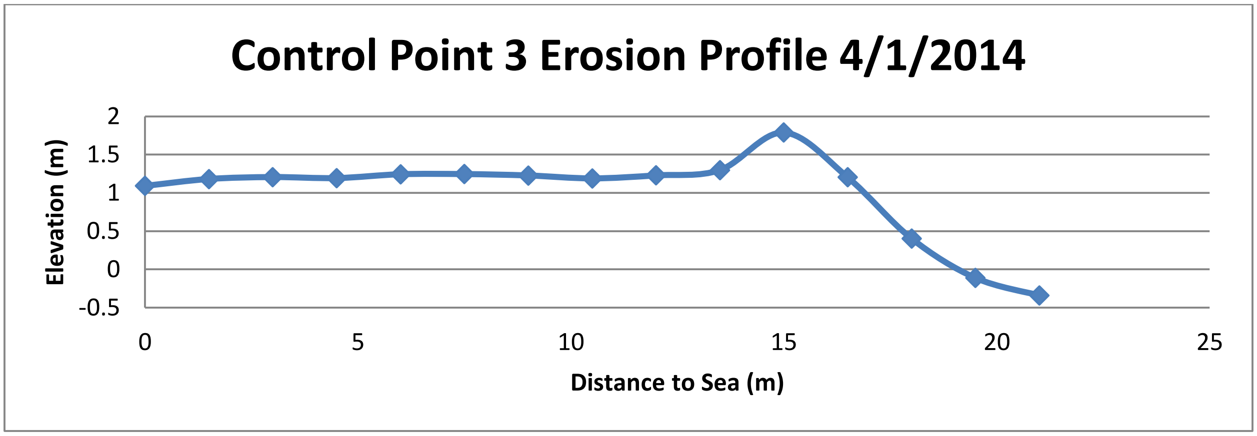

Figure 40: Control Point 3 Erosion Profile 4/1/2014

Table 32: Control Point 3 Data 4/16/2014

Control Point 3				
4/16/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.565	1.64	0.075	1.0934
1.5	1.599	1.61	0.011	1.0824
3	1.59	1.615	0.025	1.0574
4.5	1.635	1.58	-0.055	1.1124
6	1.575	1.63	0.055	1.0574
7.5	1.62	1.59	-0.03	1.0874
9	1.598	1.61	0.012	1.0754
11	1.62	1.59	-0.03	1.1054
12	1.605	1.6	-0.005	1.1104
14	1.575	1.63	0.055	1.0554
15	1.585	1.62	0.035	1.0204
17	1.57	1.64	0.07	0.9504
18	1.55	1.66	0.11	0.8404
20	1.545	1.665	0.12	0.7204
21	1.525	1.68	0.155	0.5654
23	1.505	1.7	0.195	0.3704
24	1.51	1.7	0.19	0.1804
26	1.5	1.71	0.21	-0.0296
27	1.51	1.7	0.19	-0.2196

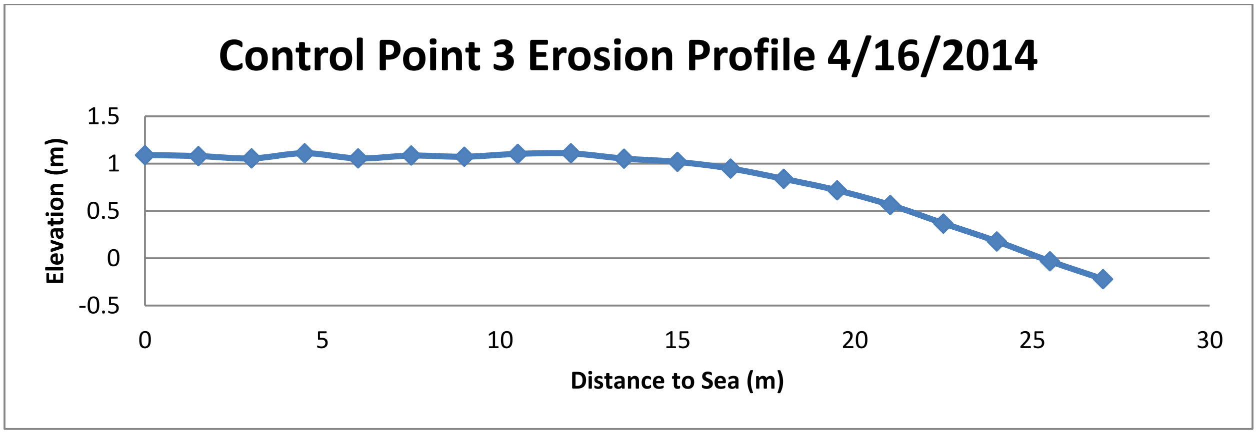

Figure 41: Control Point 3 Erosion Profile 4/16/2014

Table 33: Control Point 3 Data 4/22/2014

Control Point 3				
4/22/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.287	1.36	0.073	1.0954
1.5	1.305	1.325	0.02	1.0754
3	1.31	1.315	0.005	1.0704
4.5	1.32	1.315	-0.005	1.0754
6	1.31	1.325	0.015	1.0604
7.5	1.33	1.3	-0.03	1.0904
9	1.32	1.315	-0.005	1.0954
10.5	1.32	1.32	0	1.0954
12	1.32	1.32	0	1.0954
13.5	1.305	1.335	0.03	1.0654
15	1.3	1.345	0.045	1.0204
16.5	1.265	1.345	0.08	0.9404
18	1.23	1.375	0.145	0.7954
19.5	1.227	1.375	0.148	0.6474
21	1.22	1.38	0.16	0.4874
22.5	1.225	1.385	0.16	0.3274
24	1.23	1.38	0.15	0.1774
25.5	1.26	1.37	0.11	0.0674
27	1.265	1.335	0.07	-0.0026
28.5	1.24	1.365	0.125	-0.1276
30	1.26	1.345	0.085	-0.2126

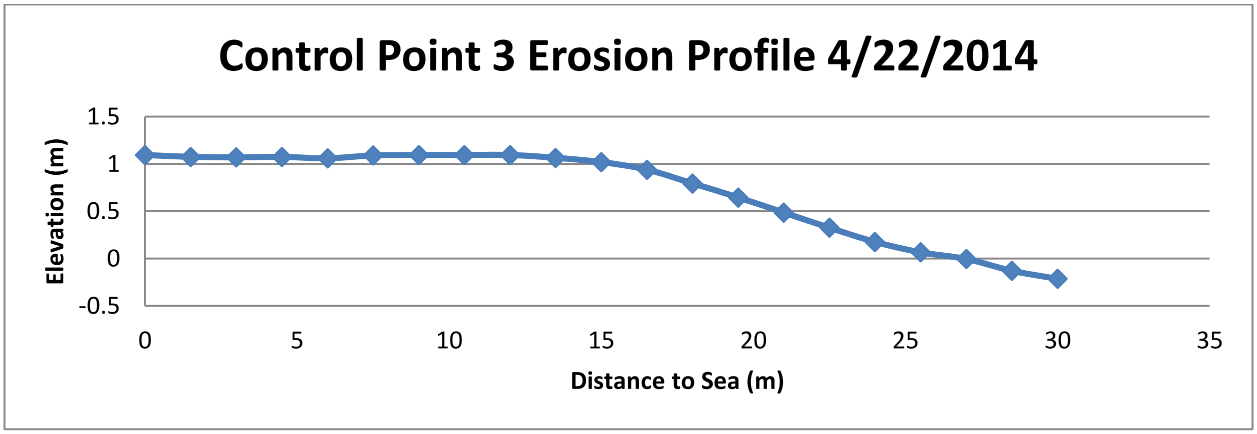

Figure 42: Control Point 3 Erosion Profile 4/22/2014

Table 34: Control Point 3 Data 4/29/2014

4/29/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.37	1.47	0.1	1.0684
1.5	1.4	1.45	0.05	1.0184
3	1.425	1.41	-0.015	1.0334
4.5	1.42	1.42	0	1.0334
6	1.405	1.44	0.035	0.9984
7.5	1.425	1.42	-0.005	1.0034
9	1.41	1.43	0.02	0.9834
10.5	1.42	1.42	0	0.9834
12	1.415	1.43	0.015	0.9684
13.5	1.395	1.45	0.055	0.9134
15	1.395	1.46	0.065	0.8484
16.5	1.375	1.47	0.095	0.7534
18	1.35	1.5	0.15	0.6034
19.5	1.33	1.52	0.19	0.4134
21	1.355	1.49	0.135	0.2784
22.5	1.31	1.53	0.22	0.0584
24	1.335	1.51	0.175	-0.1166
25.5	1.385	1.46	0.075	-0.1916
27	1.39	1.45	0.06	-0.2516
28.5	1.355	1.485	0.13	-0.3816
30	1.37	1.47	0.1	-0.4816
31.5	1.34	1.5	0.16	-0.6416
33	1.35	1.49	0.14	-0.7816
34.5	1.31	1.53	0.22	-1.0016

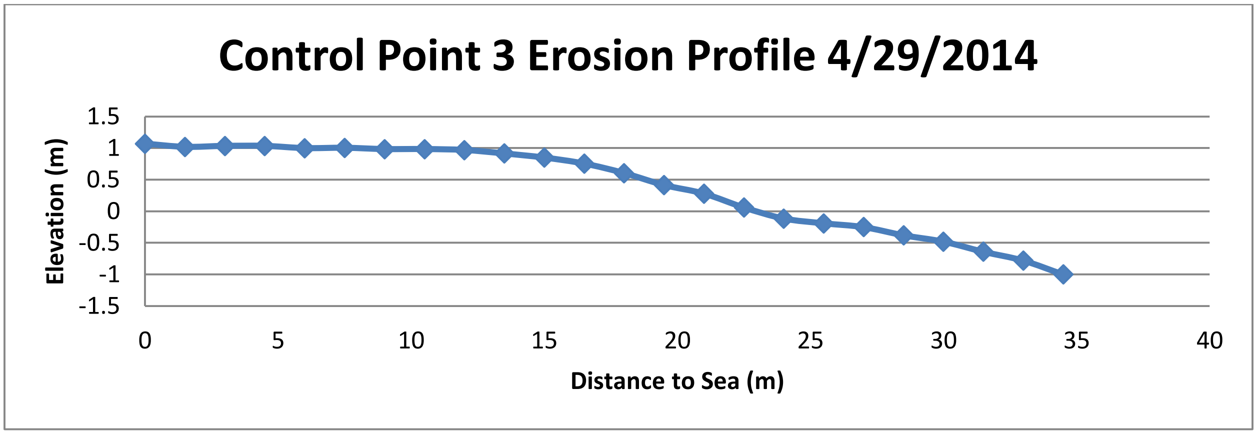

Figure 43: Control Point 3 Erosion Profile 4/29/2014

Table 35: Control Point 3 Data 5/06/2014

Control Point 3				
5/6/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Data
0	1.49	1.57	0.08	1.0884
1.5	1.52	1.54	0.02	1.0684
3	1.54	1.52	-0.02	1.0884
4.5	1.53	1.52	-0.01	1.0984
6	1.53	1.525	-0.005	1.1034
7.5	1.54	1.52	-0.02	1.1234
9	1.54	1.52	-0.02	1.1434
10.5	1.53	1.53	0	1.1434
12	1.525	1.53	0.005	1.1384
13.5	1.52	1.54	0.02	1.1184
15	1.49	1.57	0.08	1.0384
16.5	1.49	1.57	0.08	0.9584
18	1.46	1.6	0.14	0.8184
19.5	1.455	1.6	0.145	0.6734
21	1.475	1.685	0.21	0.4634
22.5	1.465	1.6	0.135	0.3284
24	1.45	1.605	0.155	0.1734
25.5	1.46	1.605	0.145	0.0284
27	1.47	1.59	0.12	-0.0916
28.5	1.48	1.58	0.1	-0.1916
30	1.46	1.605	0.145	-0.3366

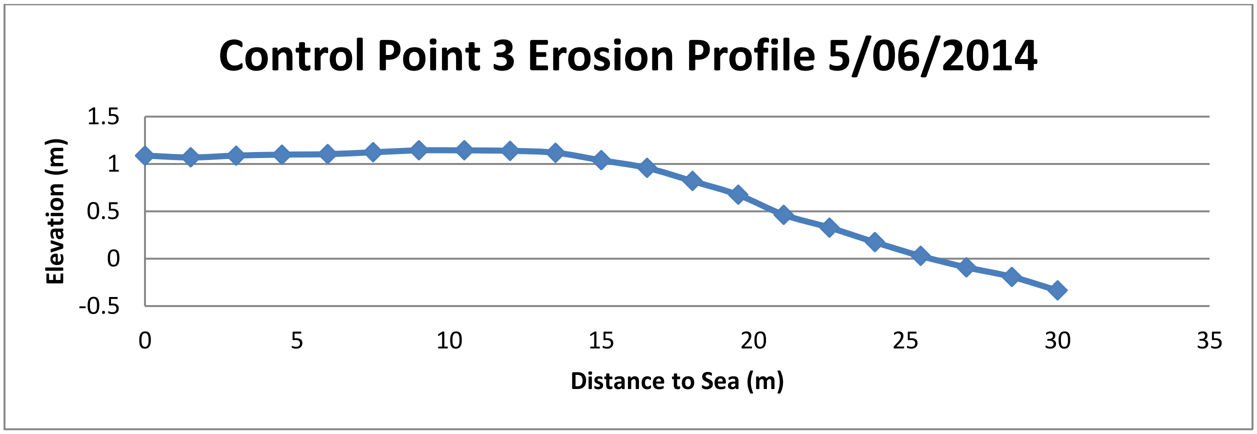

Figure 44: Control Point 3 Erosion Profile 5/06/2014

Table 36: Control Point 3 Data 5/20/2014

Control Point 3				
5/20/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.24	1.32	0.08	1.0884
1.5	1.27	1.29	0.02	1.0684
3	1.285	1.27	-0.015	1.0834
4.5	1.28	1.285	0.005	1.0784
6	1.28	1.282	0.002	1.0764
7.5	1.295	1.27	-0.025	1.1014
9	1.285	1.775	0.49	0.6114
10.5	1.28	1.28	0	0.6114
12	1.275	1.282	0.007	0.6044
13.5	1.26	1.3	0.04	0.5644
15	1.24	1.32	0.08	0.4844
16.5	1.235	1.325	0.09	0.3944
18	1.225	1.355	0.13	0.2644
19.5	1.21	1.348	0.138	0.1264
21	1.21	1.347	0.137	-0.0106
22.5	1.18	1.38	0.2	-0.2106
24	1.155	1.4	0.245	-0.4556
25.5	1.22	1.335	0.115	-0.5706
27	1.35	1.325	-0.025	-0.5456
28.5	1.25	1.315	0.065	-0.6106
30	1.275	1.33	0.055	-0.6656

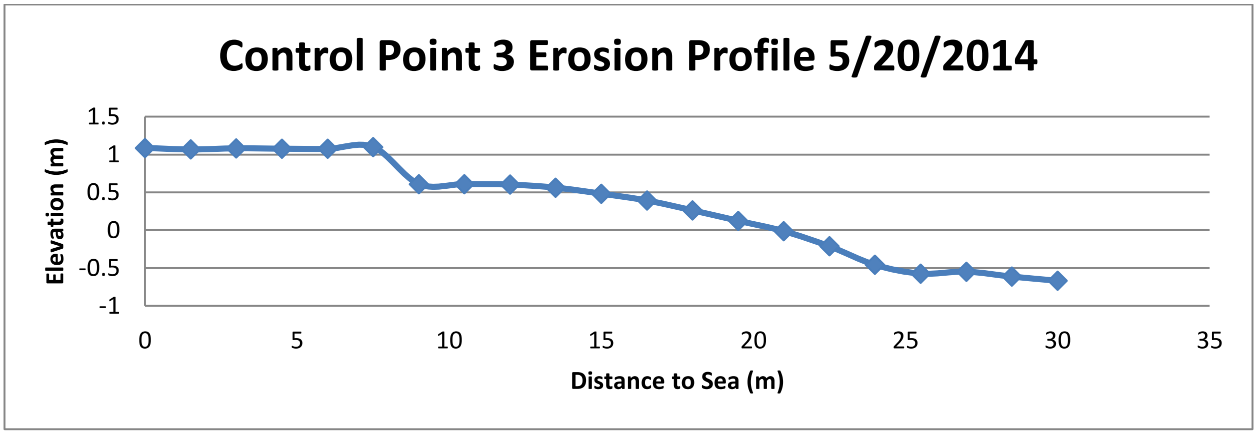

Figure 45: Control Point 3 Erosion Profile 5/20/2014

Table 37: Control Point 3 Data 5/27/2014

Control Point 3				
5/27/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.4	1.48	0.08	1.0884
1.5	1.425	1.445	0.02	1.0684
3	1.445	1.43	-0.015	1.0834
4.5	1.435	1.445	0.01	1.0734
6	1.4375	1.4375	0	1.0734
7.5	1.445	1.43	-0.015	1.0884
9	1.44	1.435	-0.005	1.0934
10.5	1.44	1.435	-0.005	1.0984
12	1.43	1.44	0.01	1.0884
13.5	1.425	1.455	0.03	1.0584
15	1.395	1.48	0.085	0.9734
16.5	1.395	1.48	0.085	0.8884
18	1.375	1.5	0.125	0.7634
19.5	1.3575	1.52	0.1625	0.6009
21	1.4	1.475	0.075	0.5259
22.5	1.35	1.545	0.195	0.3309
24	1.32	1.56	0.24	0.0909
25.5	1.4	1.475	0.075	0.0159
27	1.42	1.455	0.035	-0.0191
28.5	1.42	1.455	0.035	-0.0541
30	1.41	1.465	0.055	-0.1091
31.5	1.405	1.47	0.065	-0.1741
33	1.355	1.525	0.17	-0.3441
34.5	1.34	1.54	0.2	-0.5441
36	1.3	1.59	0.285	-0.8291

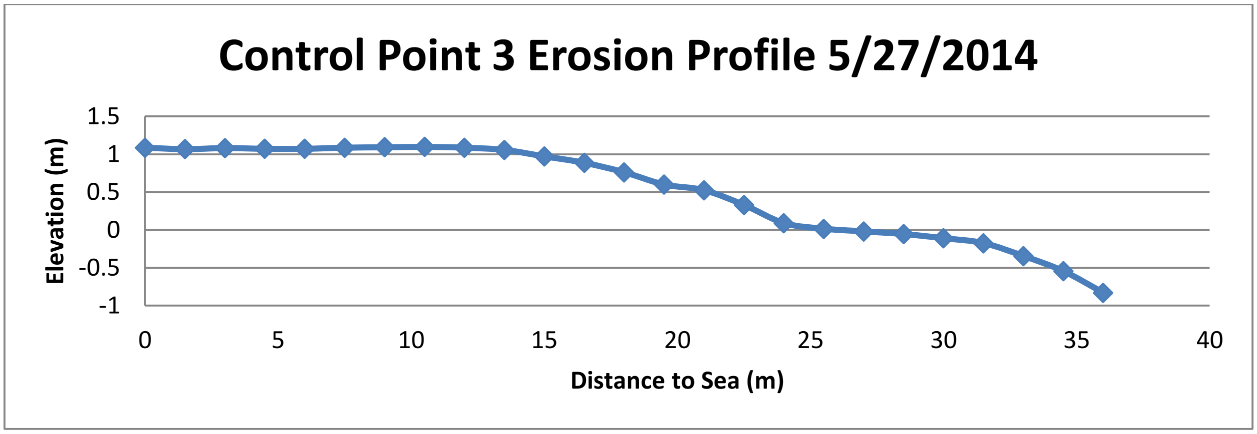

Figure 46: Control Point 3 Erosion Profile 5/27/2014

Table 38: Control Point 3 Data 6/11/2014

Control Point 3				
6/11/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.17	1.25	0.08	1.0884
1.5	1.2	1.215	0.015	1.0734
3	1.215	1.205	-0.01	1.0834
4.5	1.21	1.21	0	1.0834
6	1.205	1.22	0.015	1.0684
7.5	1.225	1.2	-0.025	1.0934
9	1.21	1.21	0	1.0934
10.5	1.21	1.21	0	1.0934
12	1.21	1.21	0	1.0934
13.5	1.2	1.225	0.025	1.0684
15	1.19	1.24	0.05	1.0184
16.5	1.18	1.25	0.07	0.9484
18	1.14	1.285	0.145	0.8034
19.5	1.14	1.285	0.145	0.6584
21	1.14	1.29	0.15	0.5084
22.5	1.15	1.28	0.13	0.3784
24	1.155	1.275	0.12	0.2584
25.5	1.09	1.335	0.245	0.0134
27	1.14	1.29	0.15	-0.1366
28.5	1.185	1.24	0.055	-0.1916
30	1.21	1.21	0	-0.1916
31.5	1.2	1.22	0.02	-0.2116
33	1.06	1.365	0.305	-0.5166
34.5	1.07	1.36	0.29	-0.8066
36	1.14	1.30	0.155	-0.9616

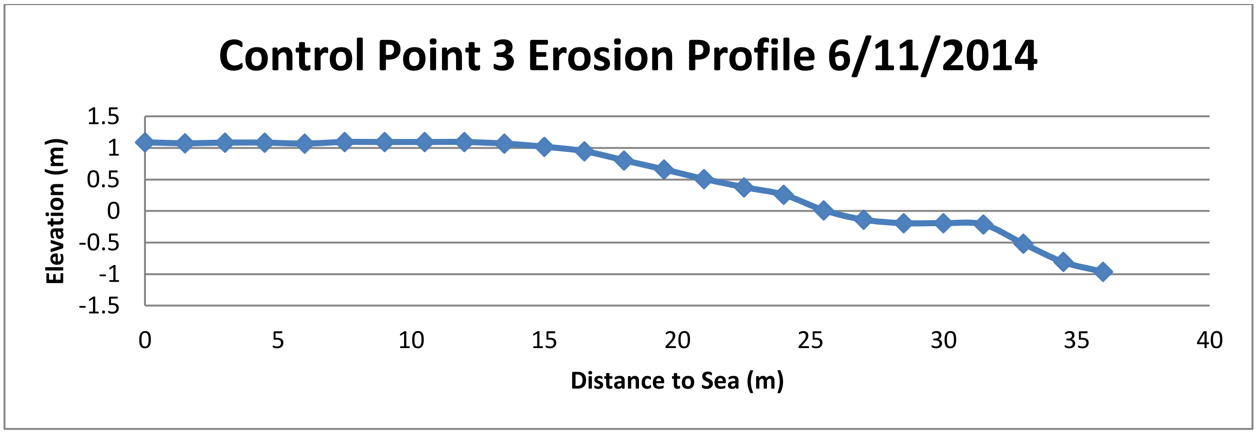

Figure 47: Control Point 3 Erosion Profile 6/11/2014

Table 39: Control Point 3 Data 6/26/2014

Control Point 3				
6/26/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.39	1.46	0.07	1.0984
1.5	1.425	1.43	0.005	1.0934
3	1.42	1.4	-0.02	1.1134
4.5	1.41	1.41	0	1.1134
6	1.39	1.41	0.02	1.0934
7.5	1.41	1.39	-0.02	1.1134
9	1.41	1.39	-0.02	1.1334
10.5	1.4	1.4	0	1.1334
12	1.4	1.4	0	1.1334
13.5	1.39	1.41	0.02	1.1134
15	1.375	1.43	0.055	1.0584
16.5	1.37	1.425	0.055	1.0034
18	1.325	1.47	0.145	0.8584
19.5	1.33	1.47	0.14	0.7184
21	1.35	1.455	0.105	0.6134
22.5	1.31	1.485	0.175	0.4384
24	1.28	1.25	-0.03	0.4684
25.5	1.36	1.44	0.08	0.3884
27	1.41	1.39	-0.02	0.4084
28.5	1.285	1.515	0.23	0.1784
30	1.3	1.5	0.2	-0.0216
31.5	1.3	1.505	0.205	-0.2266
33	1.31	1.5	0.19	-0.4166

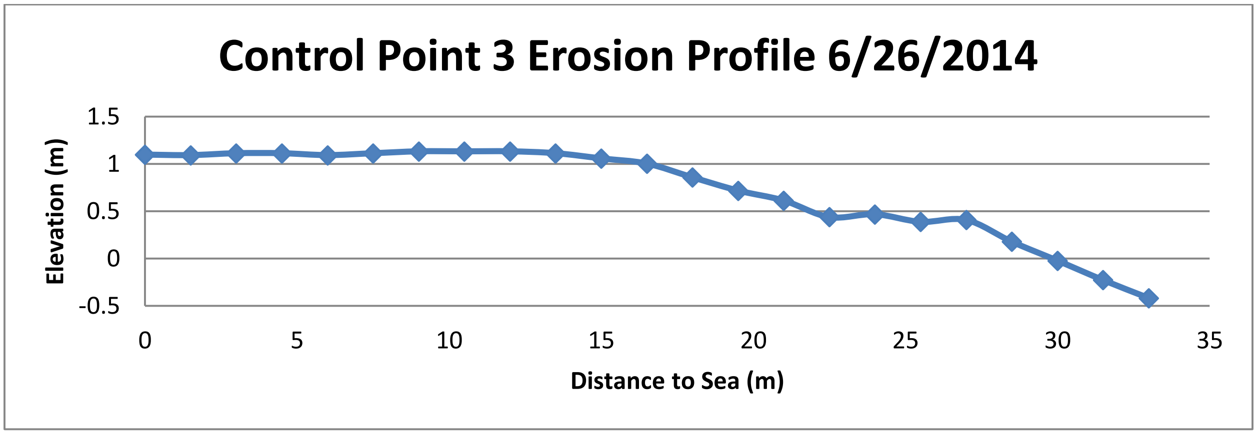

Figure 48: Control Point 3 Erosion Profile 6/26/2014

Table 40: Control Point 3 Data 8/13/2014

Control Point 3				
8/13/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.33	1.39	0.06	1.1084
1.5	1.385	1.36	-0.025	1.1334
3	1.39	1.36	-0.03	1.1634
4.5	1.38	1.37	-0.01	1.1734
6	1.375	1.375	0	1.1734
7.5	1.36	1.39	0.03	1.1434
9	1.345	1.4	0.055	1.0884
10.5	1.35	1.4	0.05	1.0384
12	1.3	1.45	0.15	0.8884
13.5	1.305	1.444	0.139	0.7494
15	1.315	1.44	0.125	0.6244
16.5	1.285	1.47	0.185	0.4394
18	1.275	1.475	0.2	0.2394
19.5	1.32	1.43	0.11	0.1294
21	1.335	1.415	0.08	0.0494
22.5	1.215	1.53	0.315	-0.2656
24	1.305	1.45	0.145	-0.4106
25.5	1.31	1.44	0.13	-0.5406
27	1.28	1.47	0.19	-0.7306
28.5	1.275	1.48	0.205	-0.9356

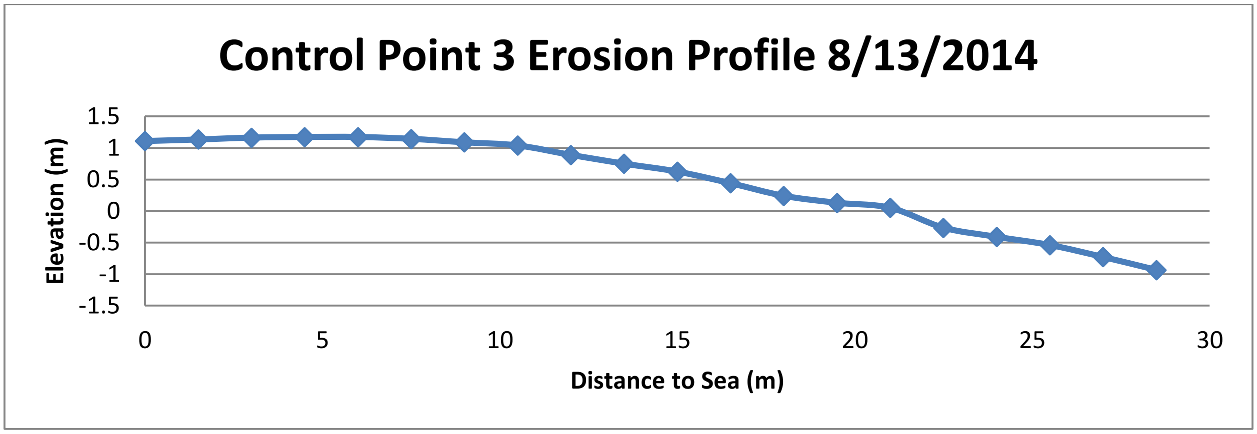

Figure 49: Control Point 3 Erosion Profile 8/13/2014

Table 41: Control Point 3 Data 8/27/2014

Control Point 3					
8/27/2014					
x	214331.3356				
y	2354415.659				
z	1.1684				
Profile A (m)			Processed Data (m)		
X	Land	Sea	Differential	Final Value	
0	1.39	1.47	0.08	1.0884	
1.5	1.43	1.415	-0.015	1.1034	
3	1.42	1.42	0	1.1034	
4.5	1.42	1.43	0.01	1.0934	
6	1.415	1.435	0.02	1.0734	
7.5	1.43	1.41	-0.02	1.0934	
9	1.435	1.415	-0.02	1.1134	
10.5	1.43	1.41	-0.02	1.1334	
12	1.41	1.43	0.02	1.1134	
13.5	1.41	1.43	0.02	1.0934	
15	1.39	1.45	0.06	1.0334	
16.5	1.375	1.37	-0.005	1.0384	
18	1.34	1.49	0.15	0.8884	
19.5	1.38	1.52	0.14	0.7484	
21	1.335	1.56	0.225	0.5234	
22.5	1.36	1.52	0.16	0.3634	
24	1.405	1.48	0.075	0.2884	
25.5	1.37	1.52	0.15	0.1384	
27	1.35	1.54	0.19	-0.0516	
28.5	1.375	1.52	0.145	-0.1966	
30	1.38	1.52	0.14	-0.3366	
31.5	1.25	1.65	0.4	-0.7366	
33	1.25	1.65	0.4	-1.1366	

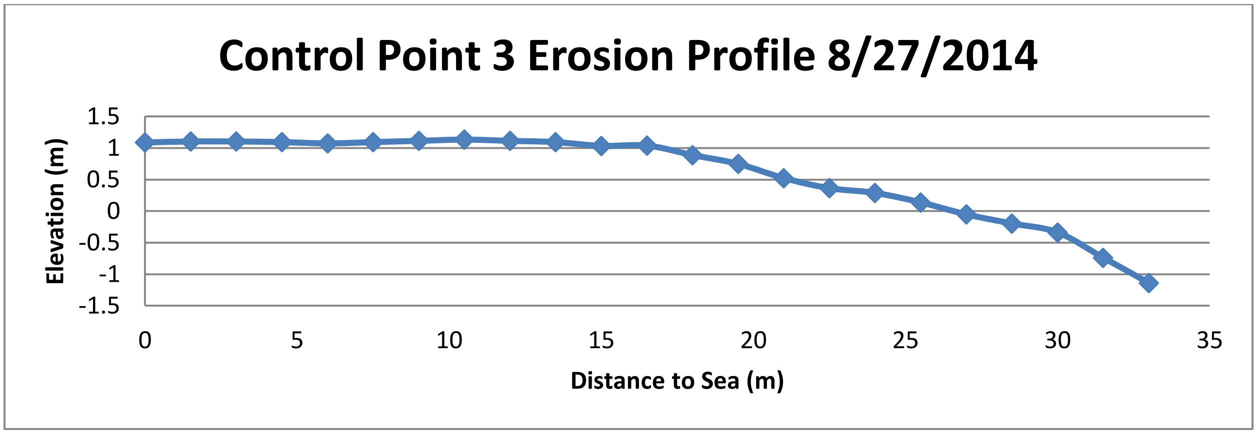

Figure 50: Control Point 3 Erosion Profile 8/27/2014

Table 42: Control Point 3 Data 9/10/2014

Control Point 3				
9/10/2014				
x	214331.3356			
y	2354415.659			
z	1.1684			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.355	1.435	0.08	1.0884
1.5	1.405	1.39	-0.015	1.1034
3	1.405	1.385	-0.02	1.1234
4.5	1.395	1.395	0	1.1234
6	1.39	1.4	0.01	1.1134
7.5	1.4	1.39	-0.01	1.1234
9	1.4	1.39	-0.01	1.1334
10.5	1.405	1.38	-0.025	1.1584
12	1.395	1.4	0.005	1.1534
13.5	1.39	1.41	0.02	1.1334
15	1.36	1.43	0.07	1.0634
16.5	1.36	1.44	0.08	0.9834
18	1.32	1.48	0.16	0.8234
19.5	1.33	1.47	0.14	0.6834
21	1.34	1.45	0.11	0.5734
22.5	1.28	1.52	0.24	0.3334
24	1.335	1.46	0.125	0.2084
25.5	1.345	1.45	0.105	0.1034
27	1.335	1.47	0.135	-0.0316
28.5	1.31	1.48	0.17	-0.2016
30	1.33	1.47	0.14	-0.3416
31.5	1.31	1.49	0.18	-0.5216
33	1.305	1.49	0.185	-0.7066
34.5	1.305	1.49	0.185	-0.8916

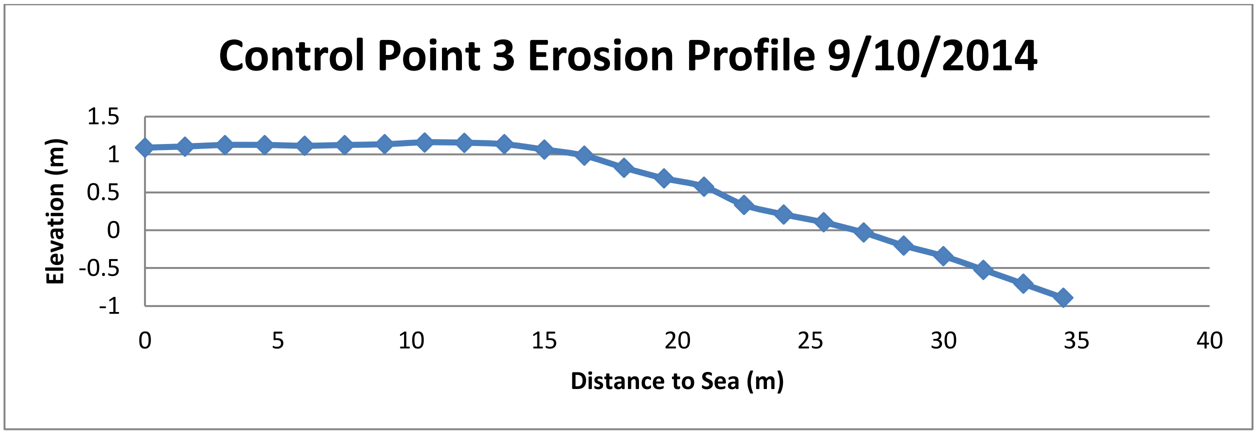

Figure 51: Control Point 3 Erosion Profile 9/10/2014

Table 43: Control Point 4 Data 4/1/2014

Control Point 4				
4/1/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.483	1.572	0.089	1.1113
1.5	1.592	1.5465	-0.0455	1.1568
3	1.152	1.54	0.388	0.7688
4.5	1.509	1.545	0.036	0.7328
6	1.479	1.522	0.043	0.6898
7.5	1.5	1.54	0.04	0.6498
9	1.541	1.51	-0.031	0.6808
10.5	1.545	1.5	-0.045	0.7258
12	1.43	1.62	0.19	0.5358
13.5	1.368	1.62	0.252	0.2838
15	1.422	1.62	0.198	0.0858
16.5	1.405	1.64	0.235	-0.1492
18	1.405	1.635	0.23	-0.3792
19.5	1.4	1.645	0.245	-0.6242
21	1.445	1.6	0.155	-0.7792
22.5	1.48	1.59	0.11	-0.8892

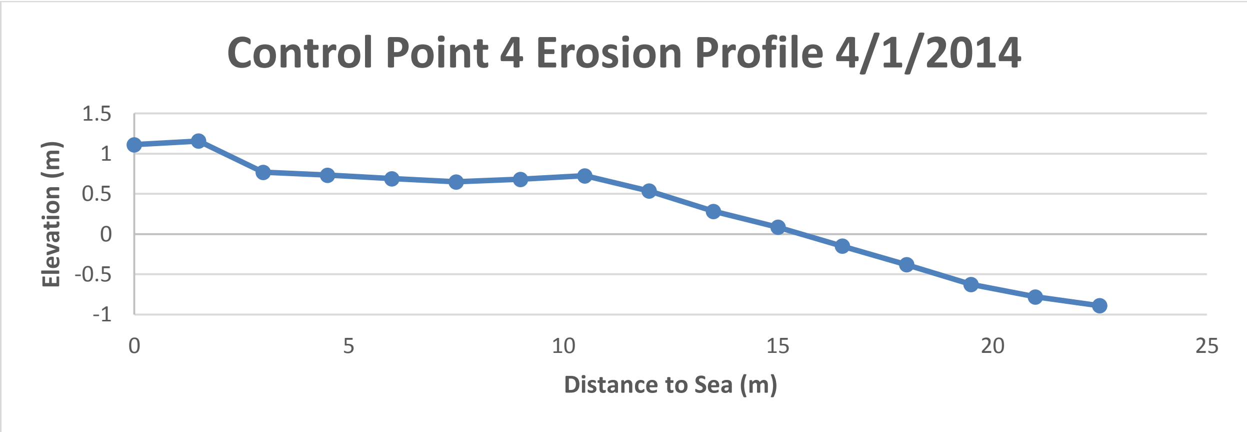

Figure 52: Control Point 4 Erosion Profile 4/1/2014

Table 44: Control Point 4 Data 4/16/2014

Control Point 4				
4/16/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.562	1.65	0.088	1.1123
1.5	1.73	1.48	-0.25	1.3623
3	1.622	1.58	-0.042	1.4043
4.5	1.599	1.61	0.011	1.3933
6	1.608	1.6	-0.008	1.4013
7.5	1.6	1.605	0.005	1.3963
9	1.572	1.63	0.058	1.3383
11	1.602	1.6	-0.002	1.3403
12	1.592	1.61	0.018	1.3223
14	1.59	1.62	0.03	1.2923
15	1.61	1.6	-0.01	1.3023
17	1.598	1.61	0.012	1.2903
18	1.545	1.66	0.115	1.1753
20	1.535	1.67	0.135	1.0403
21	1.505	1.7	0.195	0.8453
23	1.505	1.7	0.195	0.6503
24	1.485	1.72	0.235	0.4153
26	1.345	1.86	0.515	-0.0997
27	1.5	1.71	0.21	-0.3097

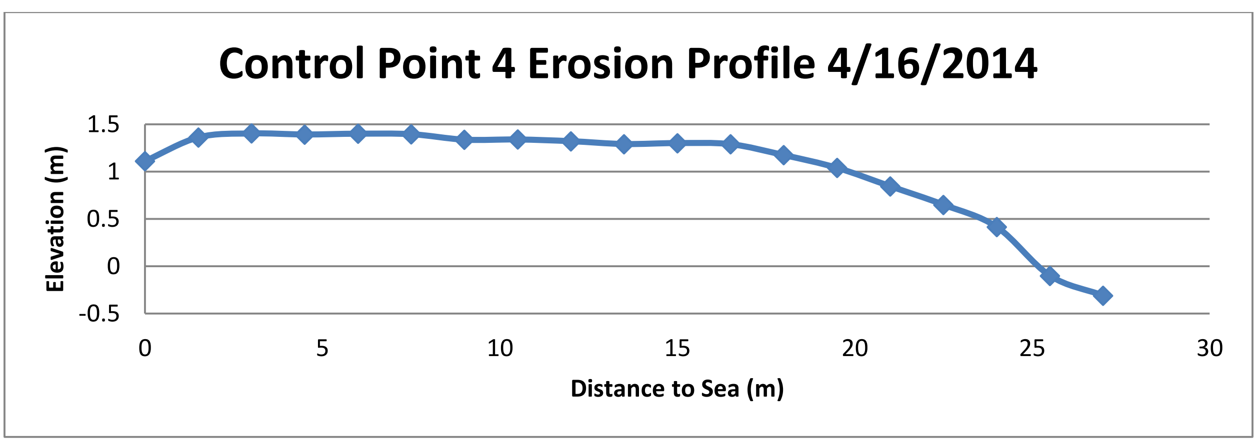

Figure 53: Control Point 4 Erosion Profile 4/16/2014

Table 45: Control Point 4 Data 4/22/2014

Control Point 4				
4/22/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.28	1.32	0.04	1.1603
1.5	1.415	1.175	-0.24	1.4003
3	1.31	1.3	-0.01	1.4103
4.5	1.3	1.31	0.01	1.4003
6	1.3	1.31	0.01	1.3903
7.5	1.3	1.31	0.01	1.3803
9	1.3	1.31	0.01	1.3703
10.5	1.3	1.305	0.005	1.3653
12	1.3	1.31	0.01	1.3553
13.5	1.3	1.305	0.005	1.3503
15	1.3	1.305	0.005	1.3453
16.5	1.237	1.275	0.038	1.3073
18	1.24	1.37	0.13	1.1773
19.5	1.22	1.39	0.17	1.0073
21	0.91	1.695	0.785	0.2223
22.5	1.225	1.38	0.155	0.0673
24	1.26	1.345	0.085	-0.0177

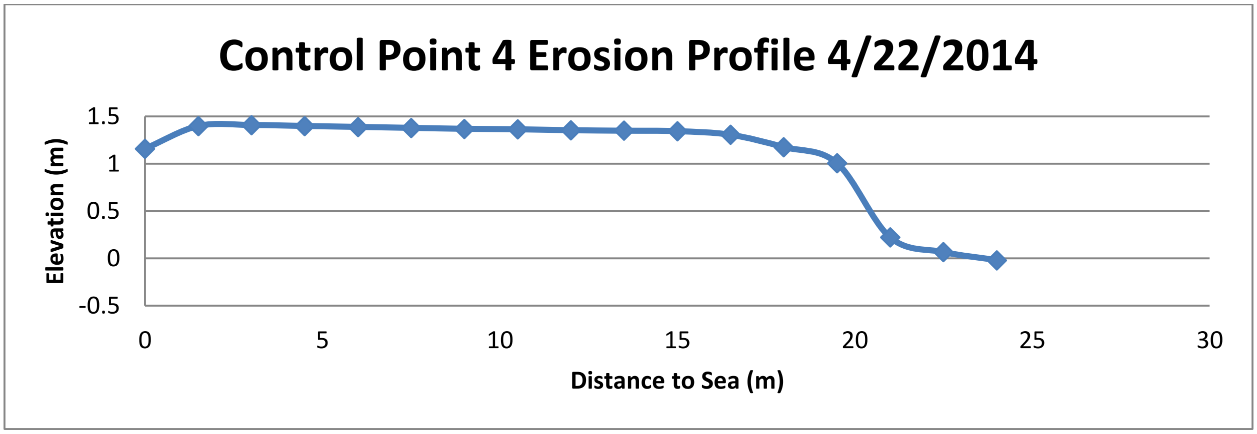

Figure 54: Control Point 4 Erosion Profile 4/22/2014

Table 46: Control Point 4 Data 4/29/2014

Control Point 4				
4/29/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.385	1.455	0.07	1.1303
1.5	1.525	1.31	-0.215	1.3453
3	1.4	1.435	0.035	1.3103
4.5	1.42	1.425	0.005	1.3053
6	1.415	1.43	0.015	1.2903
7.5	1.41	1.44	0.03	1.2603
9	1.39	1.455	0.065	1.1953
10.5	1.425	1.42	-0.005	1.2003
12	1.41	1.44	0.03	1.1703
13.5	1.4	1.45	0.05	1.1203
15	1.4	1.45	0.05	1.0703
16.5	1.39	1.45	0.06	1.0103
18	1.365	1.48	0.115	0.8953
19.5	1.33	1.52	0.19	0.7053
21	1.01	1.83	0.82	-0.1147
22.5	1.365	1.48	0.115	-0.2297
24	1.39	1.46	0.07	-0.2997
25.5	1.36	1.49	0.13	-0.4297
27	1.325	1.52	0.195	-0.6247
28.5	1.31	1.54	0.23	-0.8547

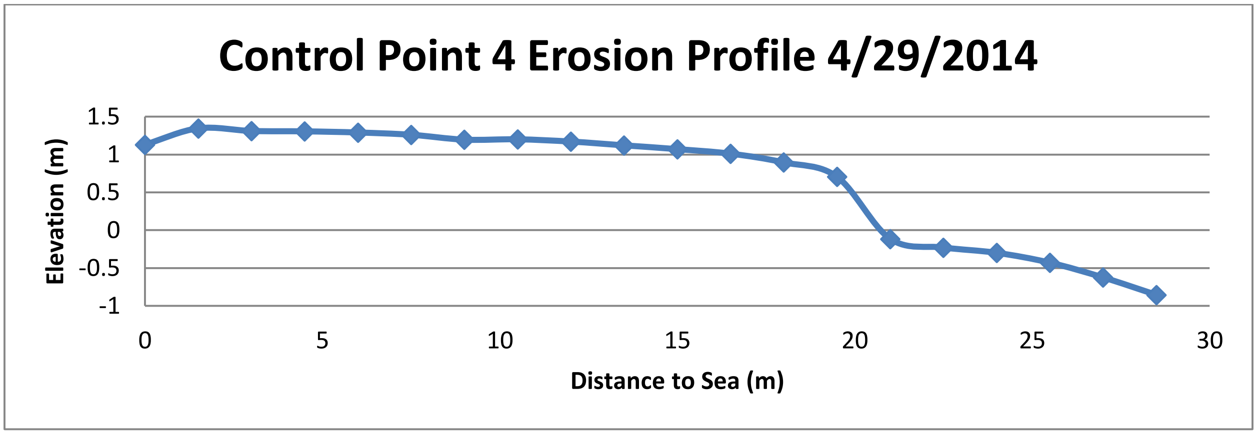

Figure 55: Control Point 4 Erosion Profile 4/29/2014

Table 47: Control Point 4 Data 5/6/2014

Control Point 4				
5/6/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.51	1.55	0.04	1.1603
1.5	1.62	1.37	-0.25	1.4103
3	1.5	1.485	-0.015	1.4253
4.5	1.49	1.5	0.01	1.4153
6	1.5	1.49	-0.01	1.4253
7.5	1.49	1.5	0.01	1.4153
9	1.47	1.515	0.045	1.3703
10.5	1.5	1.48	-0.02	1.3903
12	1.49	1.5	0.01	1.3803
13.5	1.48	1.51	0.03	1.3503
15	1.48	1.51	0.03	1.3203
16.5	1.48	1.515	0.035	1.2853
18	1.04	1.95	0.91	0.3753
19.5	1.38	1.615	0.235	0.1403
21	1.45	1.55	0.1	0.0403
22.5	1.47	1.525	0.055	-0.0147
24	1.5	1.49	-0.01	-0.0047
25.5	1.42	1.58	0.16	-0.1647

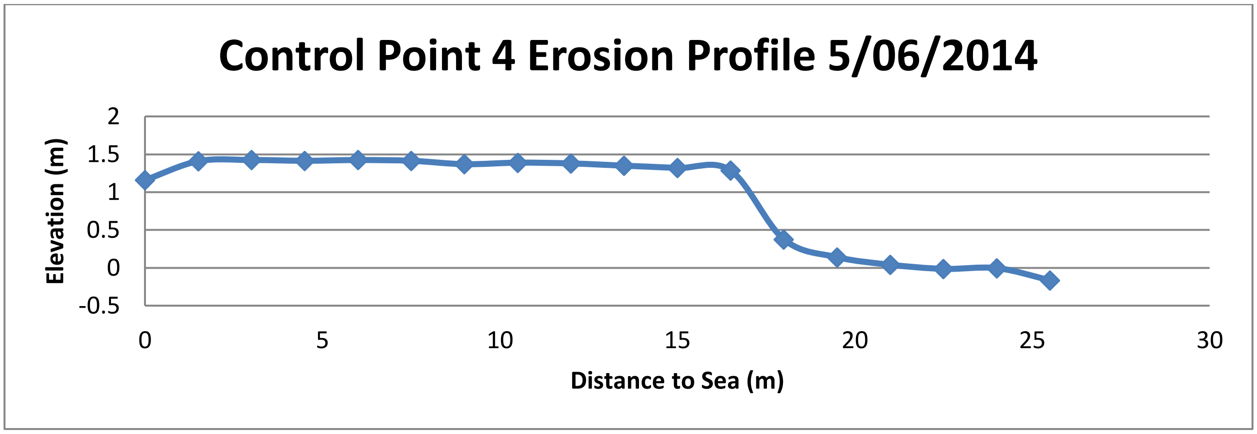

Figure 56: Control Point 4 Erosion Profile 5/6/2014

Table 48: Control Point 4 Data 5/20/2014

Control Point 4				
5/20/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.26	1.3	0.04	1.1603
1.5	1.4	1.16	-0.24	1.4003
3	1.32	1.245	-0.075	1.4753
4.5	1.245	1.315	0.07	1.4053
6	1.275	1.285	0.01	1.3953
7.5	1.265	1.295	0.03	1.3653
9	1.26	1.3	0.04	1.3253
10.5	1.295	1.265	-0.03	1.3553
12	1.265	1.3	0.035	1.3203
13.5	1.26	1.3	0.04	1.2803
15	1.257	1.305	0.048	1.2323
16.5	0.68	1.43	0.75	0.4823
18	0.845	1.245	0.4	0.0823
19.5	0.985	1.1	0.115	-0.0327
21	0.9875	1.105	0.1175	-0.1502

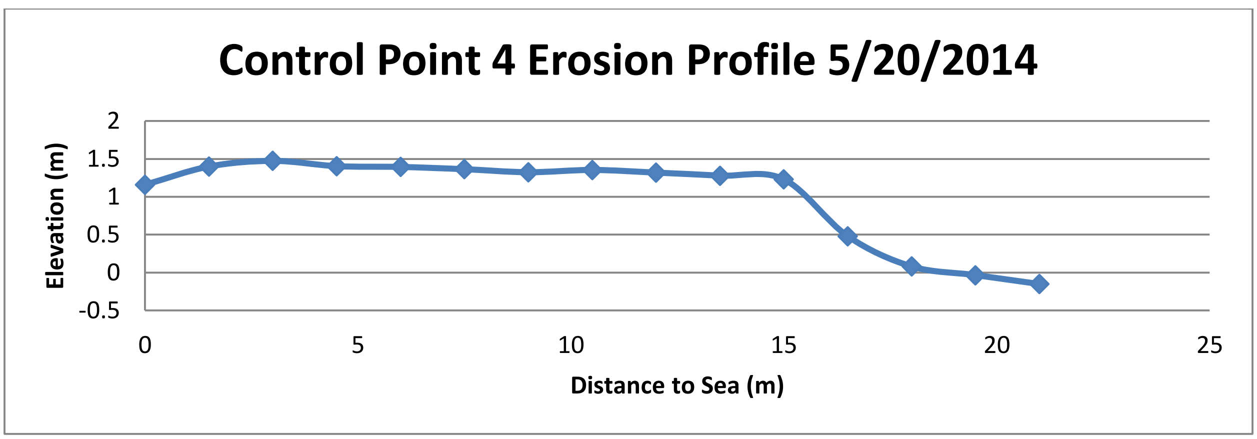

Figure 57: Control Point 4 Erosion Profile 5/20/2014

Table 49: Control Point 4 Data 5/27/2014

Control Point 4				
5/27/2014				
x	214135.0245			
y	214135.0245			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.425	1.46	0.035	1.1653
1.5	1.64	1.24	-0.4	1.5653
3	1.415	1.465	0.05	1.5153
4.5	1.385	1.5	0.115	1.4003
6	1.44	1.45	0.01	1.3903
7.5	1.435	1.55	0.115	1.2753
9	1.4275	1.7	0.2725	1.0028
10.5	1.465	1.43	-0.035	1.0378
12	1.43	1.465	0.035	1.0028
13.5	1.43	1.47	0.04	0.9628
15	1.4275	1.4675	0.04	0.9228
16.5	1.115	1.7	0.585	0.3378
18	1.115	1.5875	0.4725	-0.1347
19.5	1.305	1.4	0.095	-0.2297
21	1.4375	1.465	0.0275	-0.2572
22.5	1.435	1.46	0.025	-0.2822
24	1.31	1.505	0.195	-0.4772
25.5	1.355	1.545	0.19	-0.6672
27	1.345	1.555	0.21	-0.8772

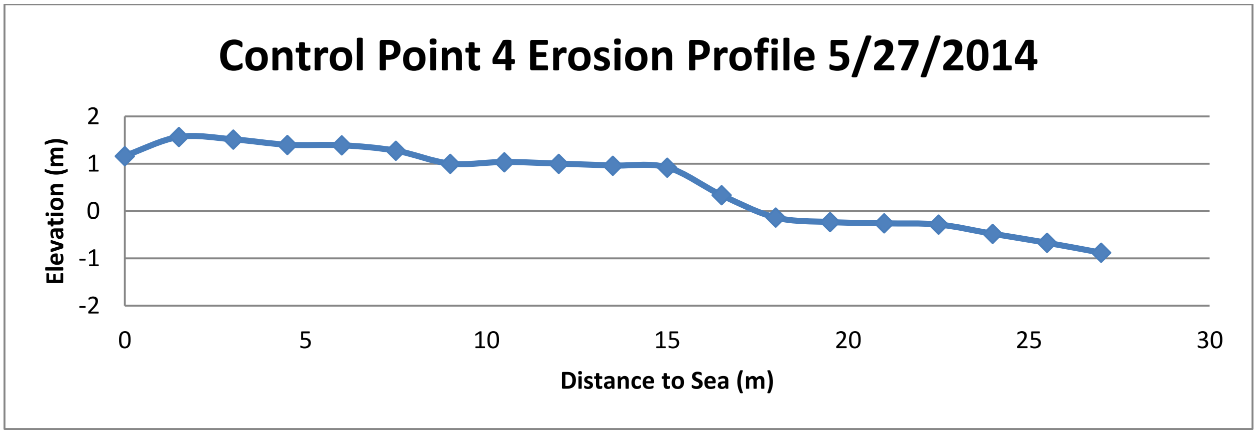

Figure 58: Control Point 4 Erosion Profile 5/27/2014

Table 50: Control Point 4 Data 6/11/2014

Control Point 4				
6/11/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.2	1.235	0.035	1.1653
1.5	1.4	1.02	-0.38	1.5453
3	1.23	1.19	-0.04	1.5853
4.5	1.13	1.29	0.16	1.4253
6	1.21	1.215	0.005	1.4203
7.5	1.205	1.22	0.015	1.4053
9	1.185	1.24	0.055	1.3503
10.5	1.215	1.21	-0.005	1.3553
12	1.21	1.21	0	1.3553
13.5	1.185	1.24	0.055	1.3003
15	1.19	1.23	0.04	1.2603
16.5	1.18	1.25	0.07	1.1903
18	0.76	1.66	0.9	0.2903
19.5	1.11	1.315	0.205	0.0853
21	1.2	1.215	0.015	0.0703
22.5	1.09	1.34	0.25	-0.1797
24	1.15	1.28	0.13	-0.3097

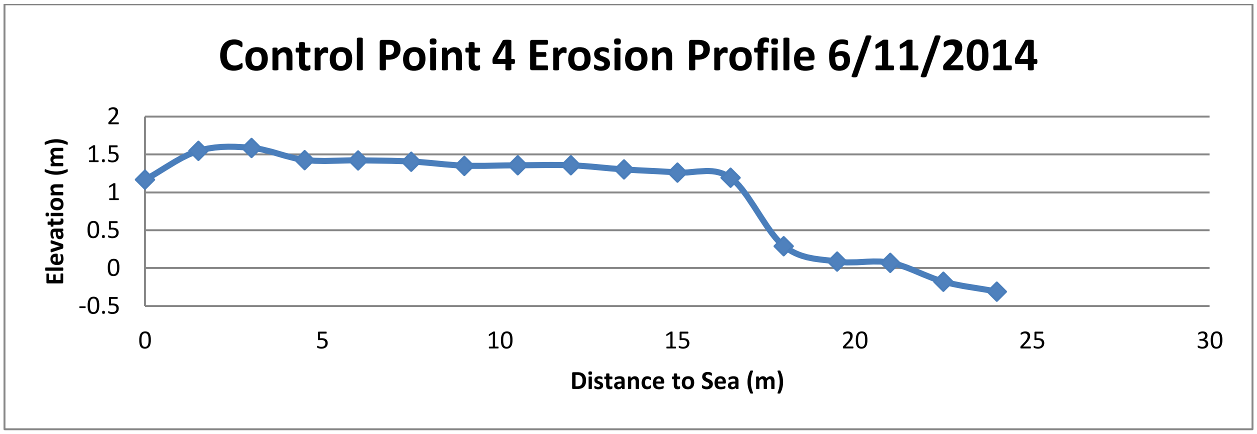

Figure 59: Control Point 4 Erosion Profile 6/11/2014

Table 51: Control Point 4 Data 6/26/2014

Control Point 4				
6/26/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.515	1.54	0.025	1.1753
1.5	1.725	1.32	-0.405	1.5803
3	1.495	1.555	0.06	1.5203
4.5	1.47	1.575	0.105	1.4153
6	1.515	1.535	0.02	1.3953
7.5	1.515	1.535	0.02	1.3753
9	1.495	1.545	0.05	1.3253
10.5	1.53	1.51	-0.02	1.3453
12	1.52	1.525	0.005	1.3403
13.5	1.5	1.455	-0.045	1.3853
15	1.51	1.525	0.015	1.3703
16.5	1.49	1.555	0.065	1.3053
18	1.05	1.99	0.94	0.3653
19.5	1.38	1.66	0.28	0.0853
21	1.465	1.57	0.105	-0.0197
22.5	1.43	1.61	0.18	-0.1997
24	1.425	1.615	0.19	-0.3897

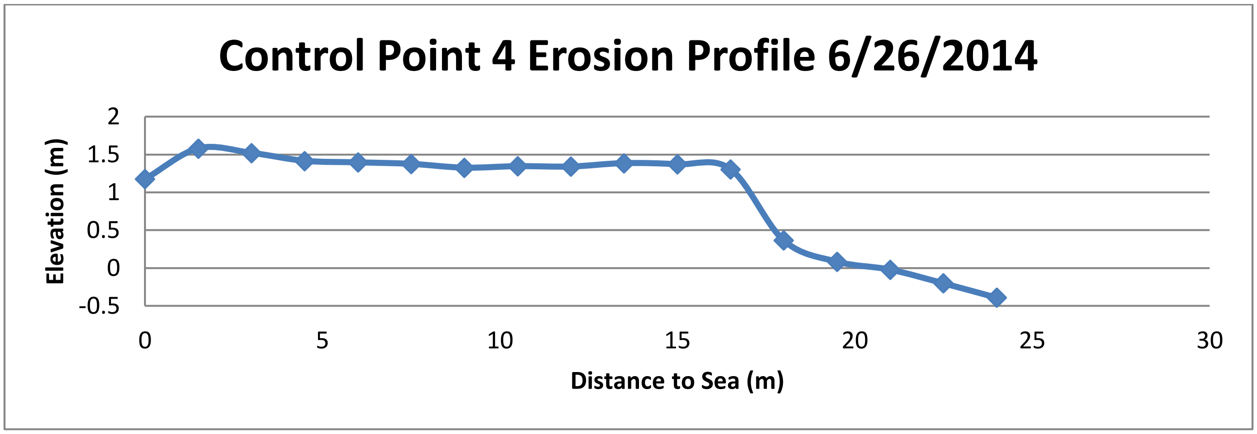

Figure 60: Control Point 4 Erosion Profile 6/26/2014

Table 52: Control Point 4 Data 8/13/2014

Control Point 4				
8/13/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.38	1.37	-0.01	1.2103
1.5	1.515	1.24	-0.275	1.4853
3	1.405	1.35	-0.055	1.5403
4.5	1.32	1.43	0.11	1.4303
6	1.365	1.39	0.025	1.4053
7.5	1.365	1.385	0.02	1.3853
9	1.36	1.39	0.03	1.3553
10.5	1.37	1.38	0.01	1.3453
12	1.38	1.37	-0.01	1.3553
13.5	1.355	1.395	0.04	1.3153
15	1.36	1.39	0.03	1.2853
16.5	1.345	1.405	0.06	1.2253
18	0.97	1.78	0.81	0.4153
19.5	1.195	1.56	0.365	0.0503
21	1.34	1.41	0.07	-0.0197
22.5	1.33	1.42	0.09	-0.1097
24	1.4	1.35	-0.05	-0.0597
25.5	1.29	1.46	0.17	-0.2297
27	1.295	1.45	0.155	-0.3847
28.5	1.29	1.46	0.17	-0.5547
30	1.275	1.48	0.205	-0.7597
31.5	1.285	1.44	0.155	-0.9147
33	1.285	1.44	0.155	-1.0697

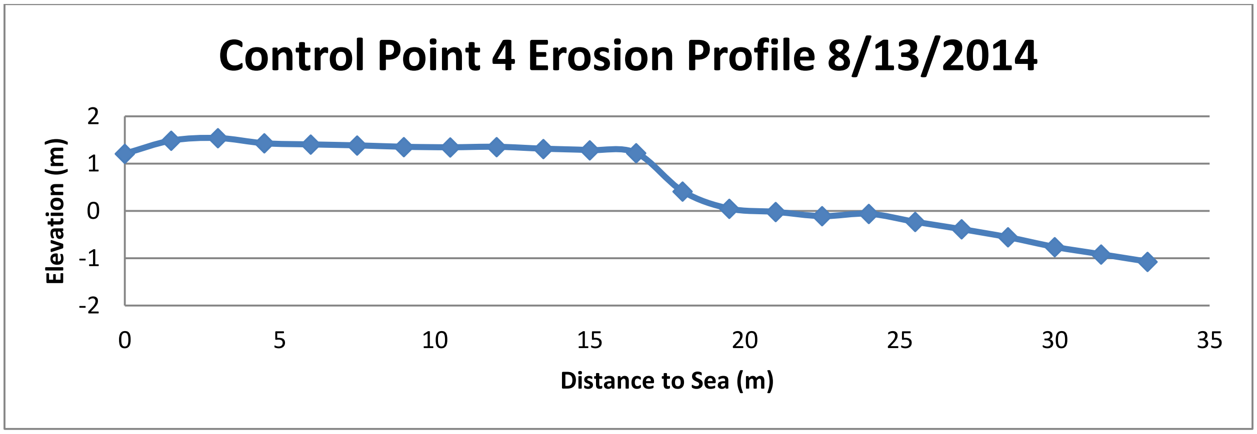

Figure 61: Control Point 4 Erosion Profile 8/13/2014

Table 53: Control Point 4 Data 8/27/2014

Control Point 4				
8/27/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.43	1.42	-0.01	1.2103
1.5	1.57	1.28	-0.29	1.5003
3	1.42	1.43	0.01	1.4903
4.5	1.38	1.47	0.09	1.4003
6	1.42	1.42	0	1.4003
7.5	1.41	1.445	0.035	1.3653
9	1.41	1.44	0.03	1.3353
10.5	1.44	1.41	-0.03	1.3653
12	1.4	1.45	0.05	1.3153
13.5	1.41	1.45	0.04	1.2753
15	1.42	1.44	0.02	1.2553
16.5	1.13	1.73	0.6	0.6553
18	1.175	1.675	0.5	0.1553
19.5	1.32	1.525	0.205	-0.0497
21	1.425	1.42	-0.005	-0.0447
22.5	1.435	1.41	-0.025	-0.0197
24	1.41	1.435	0.025	-0.0447
25.5	1.31	1.54	0.23	-0.2747
27	1.34	1.51	0.17	-0.4447
28.5	1.34	1.51	0.17	-0.6147
30	1.31	1.55	0.24	-0.8547

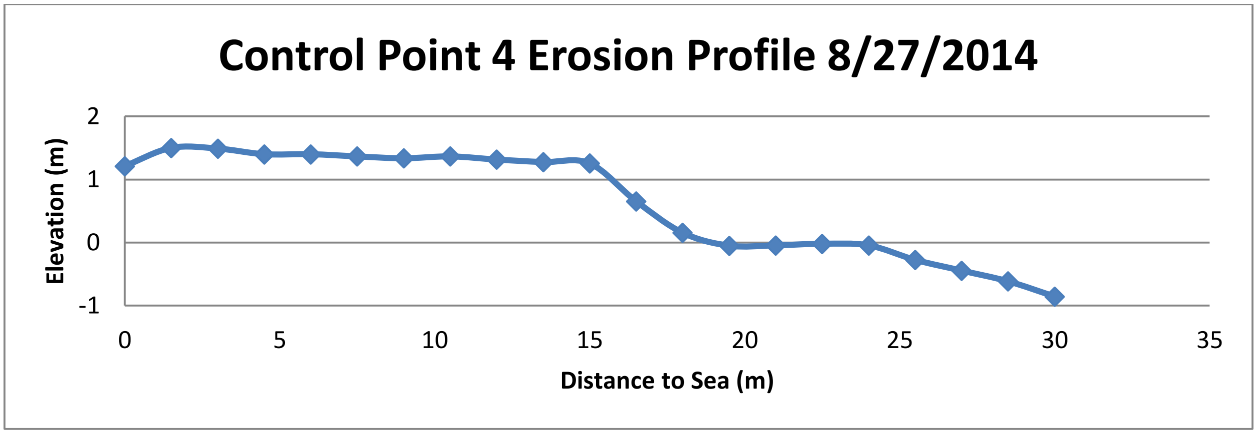

Figure 62: Control Point 4 Erosion Profile 8/27/2014

Table 54: Control Point 4 Data 9/10/2014

9/10/2014				
x	214135.0245			
y	2354370.021			
z	1.2003			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.4	1.38	-0.02	1.2203
1.5	1.54	1.26	-0.28	1.5003
3	1.415	1.38	-0.035	1.5353
4.5	1.34	1.45	0.11	1.4253
6	1.395	1.4	0.005	1.4203
7.5	1.39	1.4	0.01	1.4103
9	1.38	1.41	0.03	1.3803
10.5	1.385	1.405	0.02	1.3603
12	1.405	1.38	-0.025	1.3853
13.5	1.37	1.42	0.05	1.3353
15	1.39	1.4	0.01	1.3253
16.5	1.31	1.48	0.17	1.1553
18	0.96	1.82	0.86	0.2953
19.5	1.24	1.55	0.31	-0.0147
21	1.42	1.37	-0.05	0.0353
22.5	1.43	1.36	-0.07	0.1053
24	1.225	1.37	0.145	-0.0397
25.5	1.225	1.57	0.345	-0.3847
27	1.34	1.45	0.11	-0.4947
28.5	1.31	1.48	0.17	-0.6647
30	1.32	1.47	0.15	-0.8147
31.5	1.26	1.55	0.29	-1.1047
33	1.26	1.55	0.29	-1.3947

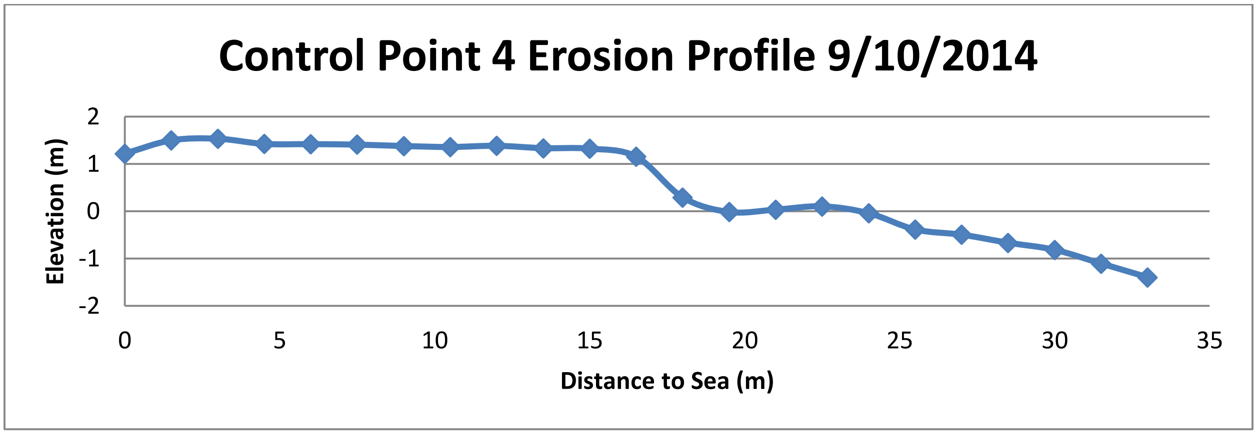

Figure 63: Control Point 4 Erosion Profile 9/10/2014

Table 55: Control Point 5 Data 4/1/2014

Control Point 5				
4/1/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.488	1.55	0.062	1.7824
1.5	1.455	1.58	0.125	1.6574
3	1.52	1.52	0	1.6574
4.5	1.4	1.63	0.23	1.4274
6	1.305	1.73	0.425	1.0024
7.5	1.405	1.58	0.175	0.8274
9	1.515	1.52	0.005	0.8224
10.5	1.525	1.51	-0.015	0.8374
12	1.491	1.545	0.054	0.7834
13.5	1.508	1.53	0.022	0.7614
15	1.49	1.55	0.06	0.7014
16.5	1.413	1.62	0.207	0.4944
18	1.48	1.55	0.07	0.4244
19.5	1.435	1.6	0.165	0.2594
21	1.358	1.68	0.322	-0.0626
22.5	1.4	1.64	0.24	-0.3026
24	1.451	1.59	0.139	-0.4416
25.5	1.45	1.59	0.14	-0.5816

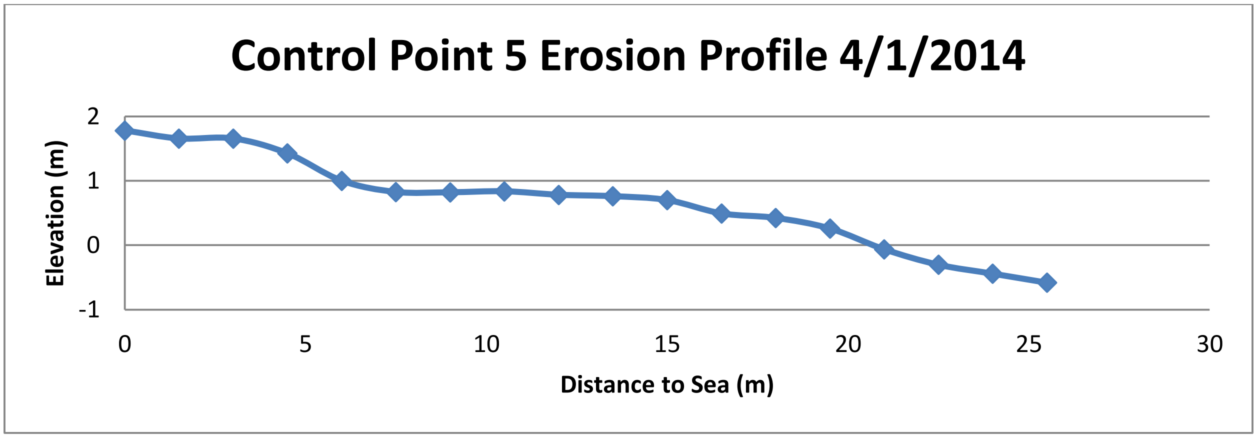

Figure 64: Control Point 5 Erosion Profile 4/1/2014

Table 56: Control Point 5 Data 4/16/2014

Control Point 5				
4/16/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.33	1.355	0.025	1.8194
1.5	1.265	1.41	0.145	1.6744
3	1.32	1.35	0.03	1.6444
4.5	1.24	1.43	0.19	1.4544
6	1.135	1.54	0.405	1.0494
7.5	1.251	1.42	0.169	0.8804
9	1.32	1.35	0.03	0.8504
10.5	1.34	1.33	-0.01	0.8604
12	1.32	1.35	0.03	0.8304
13.5	1.325	1.35	0.025	0.8054
15	1.305	1.365	0.06	0.7454
16.5	1.155	1.515	0.36	0.3854
18	1.265	1.41	0.145	0.2404
19.5	1.315	1.355	0.04	0.2004
21	1.265	1.41	0.145	0.0554
22.5	1.235	1.435	0.2	-0.1446

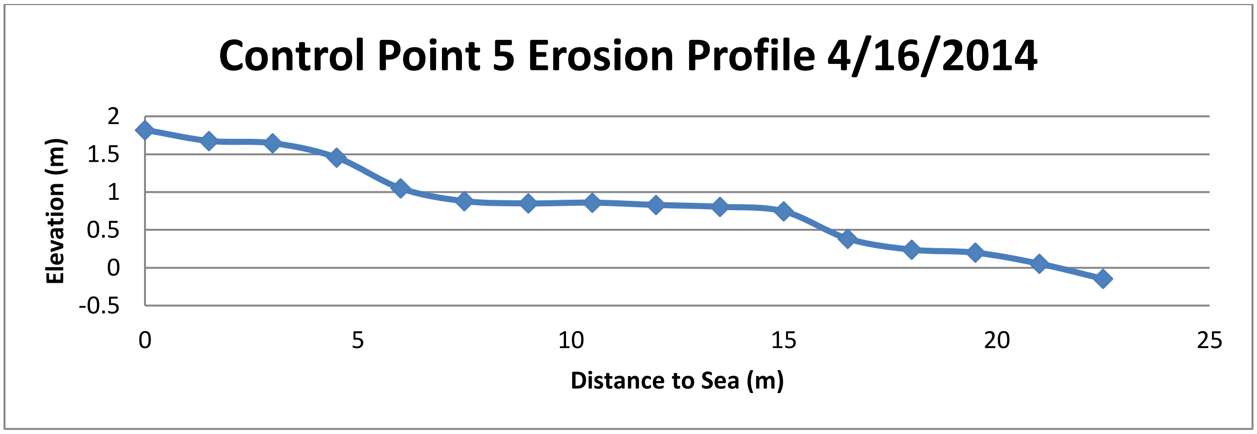

Figure 65: Control Point 5 Erosion Profile 4/16/2014

Table 57: Control Point 5 Data 4/22/2014

Control Point 5				
4/22/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.275	1.31	0.035	1.8094
1.5	1.24	1.37	0.13	1.6794
3	1.285	1.315	0.03	1.6494
4.5	1.118	1.42	0.302	1.3474
6	1.11	1.47	0.36	0.9874
7.5	1.21	1.375	0.165	0.8224
9	1.29	1.31	0.02	0.8024
10.5	1.31	1.285	-0.025	0.8274
12	1.28	1.32	0.04	0.7874
13.5	1.28	1.315	0.035	0.7524
15	1.17	1.42	0.25	0.5024
16.5	1.18	1.41	0.23	0.2724
18	1.21	1.38	0.17	0.1024
19.5	1.235	1.36	0.125	-0.0226
21	1.22	1.365	0.145	-0.1676
22.5	1.24	1.34	0.1	-0.2676

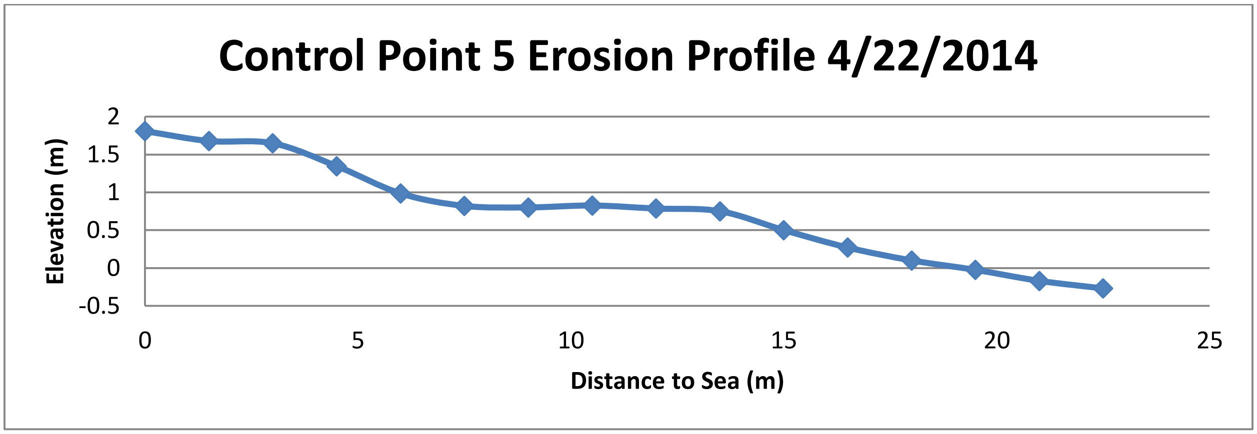

Figure 66: Control Point 5 Erosion Profile 4/22/2014

Table 58: Control Point 5 Data 4/29/2014

Control Point 5				
4/29/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.39	1.46	0.07	1.7744
1.5	1.36	1.49	0.13	1.6444
3	1.405	1.44	0.035	1.6094
4.5	1.31	1.545	0.235	1.3744
6	1.24	1.505	0.265	1.1094
7.5	1.33	1.52	0.19	0.9194
9	1.39	1.46	0.07	0.8494
10.5	1.42	1.425	0.005	0.8444
12	1.4	1.445	0.045	0.7994
13.5	1.405	1.44	0.035	0.7644
15	1.34	1.52	0.18	0.5844
16.5	1.335	1.6	0.265	0.3194
18	1.35	1.58	0.23	0.0894
19.5	1.39	1.54	0.15	-0.0606

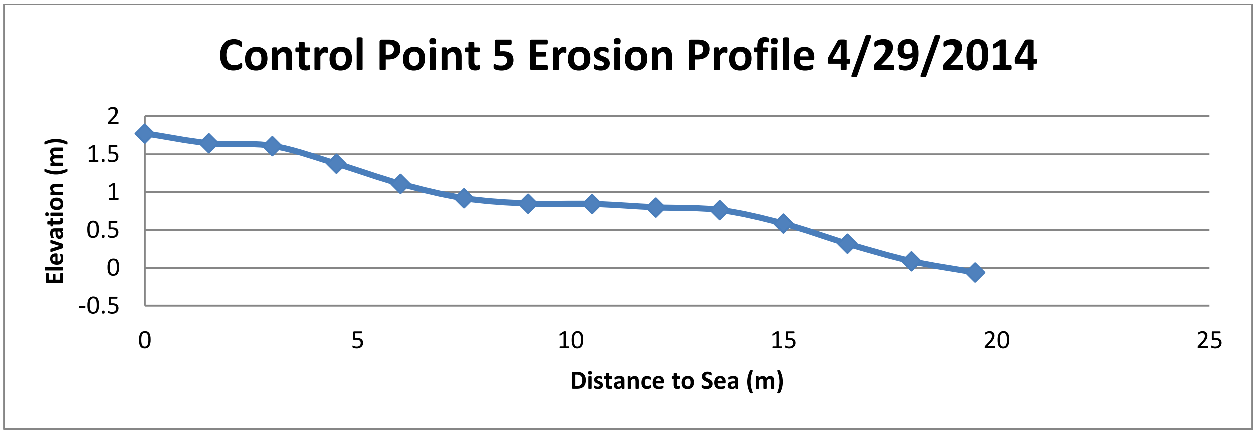

Figure 67: Control Point 5 Erosion Profile 4/29/2014

Table 59: Control Point 5 Data 5/6/2014

Control Point 5				
5/6/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.46	1.53	0.07	1.7744
1.5	1.425	1.555	0.13	1.6444
3	1.48	1.515	0.035	1.6094
4.5	1.37	1.625	0.255	1.3544
6	1.34	1.65	0.31	1.0444
7.5	1.41	1.585	0.175	0.8694
9	1.47	1.52	0.05	0.8194
10.5	1.52	1.47	-0.05	0.8694
12	1.46	1.53	0.07	0.7994
13.5	1.475	1.51	0.035	0.7644
15	1.365	1.63	0.265	0.4994
16.5	1.38	1.62	0.24	0.2594
18	1.42	1.57	0.15	0.1094
19.5	1.45	1.54	0.09	0.0194
21	1.42	1.57	0.15	-0.1306
22.5	1.51	1.49	-0.02	-0.1106
24	1.45	1.54	0.09	-0.2006
25.5	1.42	1.575	0.155	-0.3556

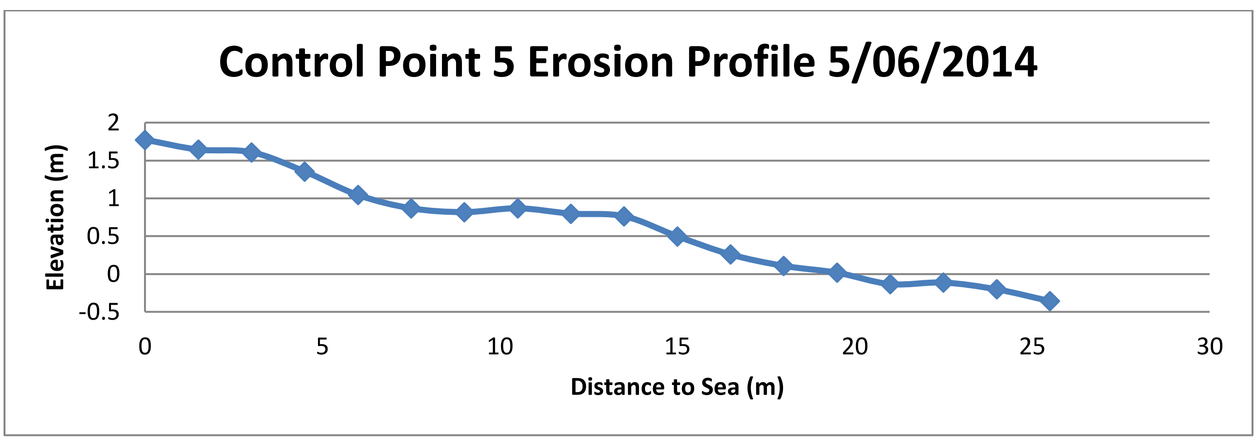

Figure 68: Control Point 5 Erosion Profile 5/6/2014

Table 60: Control Point 5 Data 5/27/2014

Control Point 5				
5/27/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.435	1.47	0.035	1.8094
1.5	1.38	1.525	0.145	1.6644
3	1.425	1.475	0.05	1.6144
4.5	1.36	1.54	0.18	1.4344
6	1.2525	1.65	0.3975	1.0369
7.5	1.3625	1.54	0.1775	0.8594
9	1.445	1.46	0.015	0.8444
10.5	1.445	1.445	0	0.8444
12	1.43	1.475	0.045	0.7994
13.5	1.435	1.465	0.03	0.7694
15	1.295	1.61	0.315	0.4544
16.5	1.255	1.645	0.39	0.0644
18	1.385	1.52	0.135	-0.0706
19.5	1.42	1.48	0.06	-0.1306
21	1.4325	1.475	0.0425	-0.1731
22.5	1.46	1.45	-0.01	-0.1631
24	1.49	1.42	-0.07	-0.0931
25.5	1.4425	1.465	0.0225	-0.1156
27	1.335	1.575	0.24	-0.3556
28.5	1.34	1.575	0.235	-0.5906
30	1.385	1.53	0.145	-0.7356

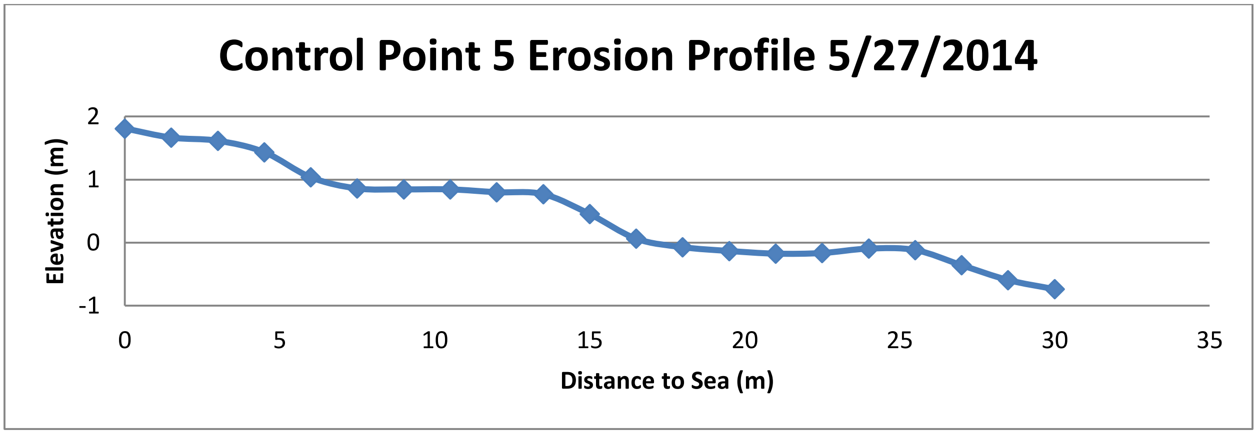

Figure 69: Control Point 5 Erosion Profile 5/27/2014

Table 61: Control Point 5 Data 6/11/2014

Control Point 5				
6/11/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.19	1.24	0.05	1.7944
1.5	1.15	1.27	0.12	1.6744
3	1.2	1.225	0.025	1.6494
4.5	1.11	1.31	0.2	1.4494
6	1.03	1.4	0.37	1.0794
7.5	1.12	1.3	0.18	0.8994
9	1.2	1.22	0.02	0.8794
10.5	1.225	1.2	-0.025	0.9044
12	1.18	1.24	0.06	0.8444
13.5	1.2	1.22	0.02	0.8244
15	1.07	1.36	0.29	0.5344
16.5	1.01	1.42	0.41	0.1244
18	1.14	1.285	0.145	-0.0206
19.5	1.18	1.24	0.06	-0.0806
21	1.19	1.23	0.04	-0.1206
22.5	1.25	1.17	-0.08	-0.0406
24	1.25	1.17	-0.08	0.0394
25.5	1.18	1.24	0.06	-0.0206
27	1.11	1.32	0.21	-0.2306
28.5	1.14	1.29	0.15	-0.3806

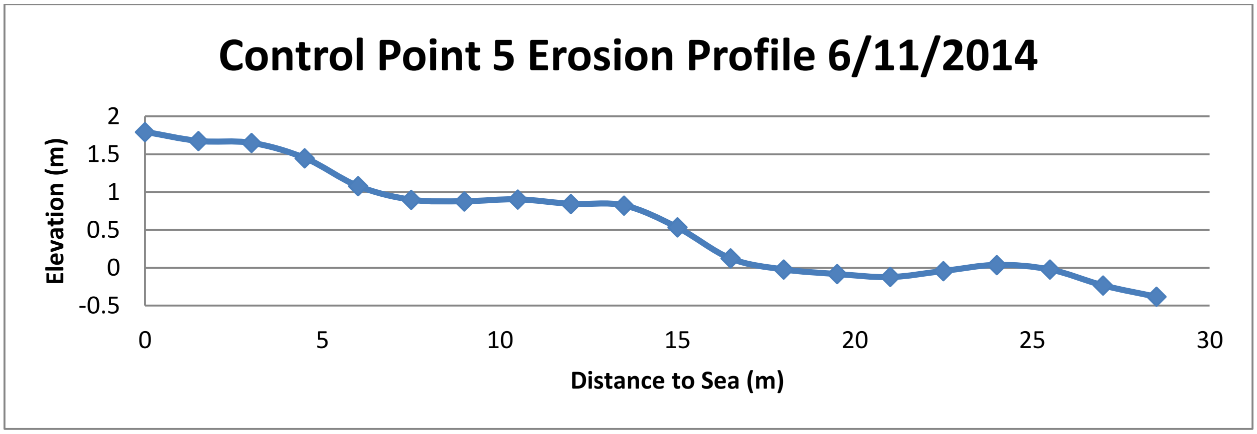

Figure 70: Control Point 5 Erosion Profile 6/11/2014

Table 62: Control Point 5 Data 6/26/2014

Control Point 5				
6/26/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.495	1.54	0.045	1.7994
1.5	1.45	1.585	0.135	1.6644
3	1.495	1.535	0.04	1.6244
4.5	1.42	1.62	0.2	1.4244
6	1.36	1.675	0.315	1.1094
7.5	1.4	1.635	0.235	0.8744
9	1.5	1.535	0.035	0.8394
10.5	1.525	1.505	-0.02	0.8594
12	1.495	1.535	0.04	0.8194
13.5	1.51	1.525	0.015	0.8044
15	1.41	1.625	0.215	0.5894
16.5	1.365	1.675	0.31	0.2794
18	1.38	1.655	0.275	0.0044
19.5	1.475	1.56	0.085	-0.0806
21	1.51	1.52	0.01	-0.0906
22.5	1.545	1.485	-0.06	-0.0306
24	1.545	1.485	-0.06	0.0294
25.5	1.42	1.625	0.205	-0.1756
27	1.405	1.635	0.23	-0.4056
28.5	1.43	1.625	0.195	-0.6006

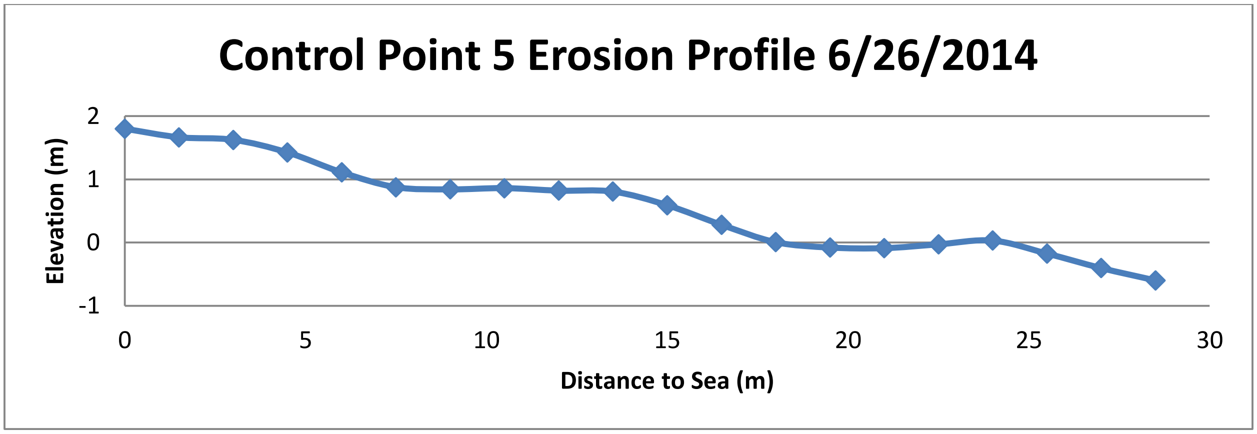

Figure 71: Control Point 5 Erosion Profile 6/26/2014

Table 63: Control Point 5 Data 8/13/2014

Control Point 5				
8/13/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.37	1.385	0.015	1.8294
1.5	1.295	1.45	0.155	1.6744
3	1.355	1.4	0.045	1.6294
4.5	1.24	1.48	0.24	1.3894
6	1.2	1.55	0.35	1.0394
7.5	1.28	1.47	0.19	0.8494
9	1.355	1.4	0.045	0.8044
10.5	1.395	1.35	-0.045	0.8494
12	1.35	1.4	0.05	0.7994
13.5	1.34	1.41	0.07	0.7294
15	1.23	1.52	0.29	0.4394
16.5	1.22	1.53	0.31	0.1294
18	1.285	1.46	0.175	-0.0456
19.5	1.34	1.4	0.06	-0.1056
21	1.395	1.35	-0.045	-0.0606
22.5	1.395	1.35	-0.045	-0.0156
24	1.285	1.46	0.175	-0.1906
25.5	1.305	1.44	0.135	-0.3256
27	1.31	1.44	0.13	-0.4556
28.5	1.295	1.45	0.155	-0.6106
30	1.29	1.46	0.17	-0.7806
31.5	1.31	1.44	0.13	-0.9106
33	1.31	1.44	0.13	-1.0406

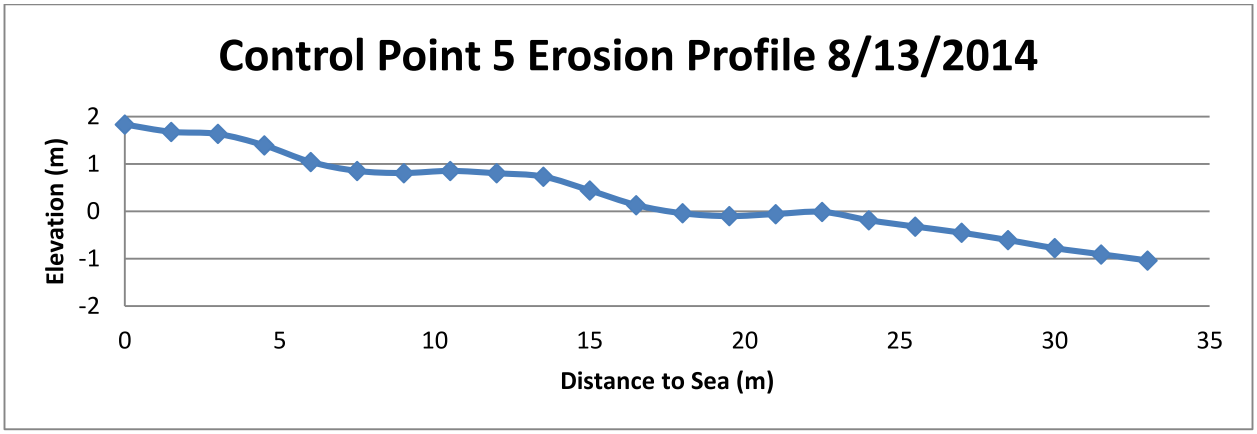

Figure 72: Control Point 5 Erosion Profile 8/13/2014

Table 64: Control Point 5 Data 8/27/2014

Control Point 5				
8/27/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.395	1.41	0.015	1.8294
1.5	1.34	1.5	0.16	1.6694
3	1.4	1.45	0.05	1.6194
4.5	1.3	1.55	0.25	1.3694
6	1.27	1.57	0.3	1.0694
7.5	1.33	1.51	0.18	0.8894
9	1.4	1.45	0.05	0.8394
10.5	1.43	1.41	-0.02	0.8594
12	1.395	1.44	0.045	0.8144
13.5	1.37	1.47	0.1	0.7144
15	1.27	1.56	0.29	0.4244
16.5	1.27	1.57	0.3	0.1244
18	1.33	1.5	0.17	-0.0456
19.5	1.41	1.42	0.01	-0.0556
21	1.45	1.38	-0.07	0.0144
22.5	1.4	1.43	0.03	-0.0156
24	1.29	1.54	0.25	-0.2656
25.5	1.34	1.47	0.13	-0.3956
27	1.32	1.5	0.18	-0.5756
28.5	1.34	1.3	-0.04	-0.5356

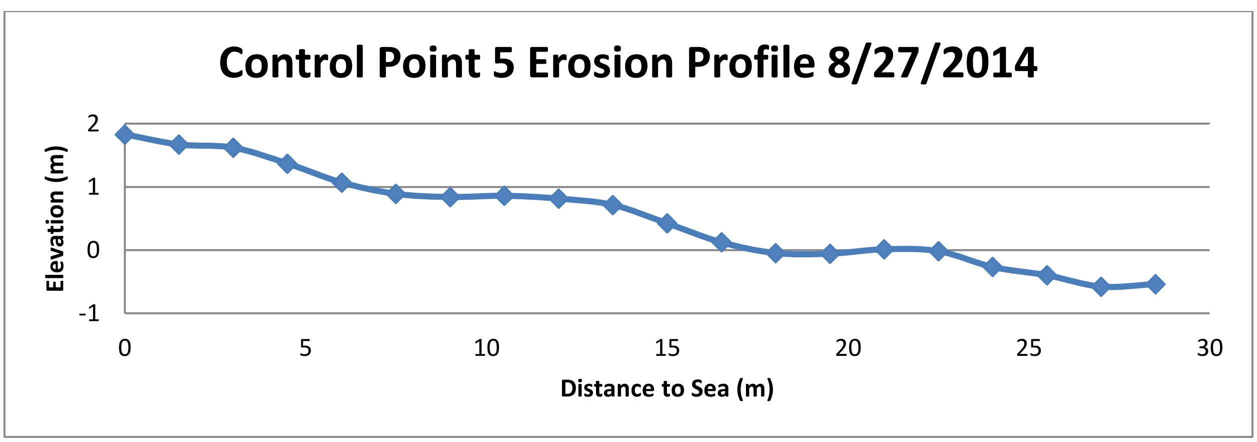

Figure 73: Control Point 5 Erosion Profile 8/27/2014

Table 65: Control Point 5 Data 9/10/2014

Control Point 5				
9/10/2014				
x	213923.6982			
y	2354327.656			
z	1.8444			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.37	1.4	0.03	1.8144
1.5	1.31	1.47	0.16	1.6544
3	1.37	1.41	0.04	1.6144
4.5	1.26	1.52	0.26	1.3544
6	1.24	1.54	0.3	1.0544
7.5	1.31	1.47	0.16	0.8944
9	1.37	1.41	0.04	0.8544
10.5	1.39	1.39	0	0.8544
12	1.35	1.43	0.08	0.7744
13.5	1.35	1.44	0.09	0.6844
15	1.245	1.54	0.295	0.3894
16.5	1.27	1.51	0.24	0.1494
18	1.27	1.505	0.235	-0.0856
19.5	1.42	1.36	-0.06	-0.0256
21	1.415	1.36	-0.055	0.0294
22.5	1.28	1.5	0.22	-0.1906
24	1.335	1.45	0.115	-0.3056
25.5	1.32	1.455	0.135	-0.4406
27	1.3	1.48	0.18	-0.6206
28.5	1.29	1.5	0.21	-0.8306
30	1.29	1.5	0.21	-1.0406

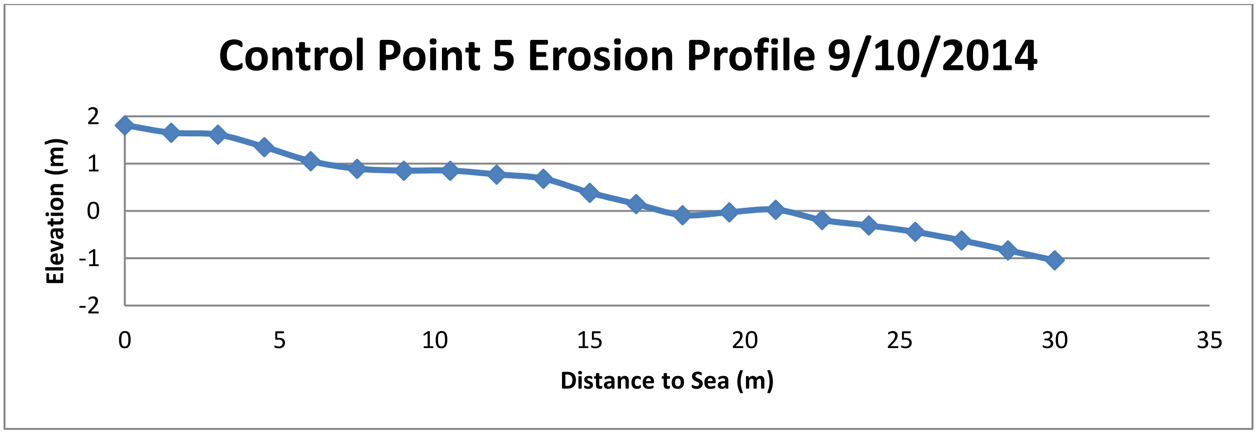

Figure 74: Control Point 5 Erosion Profile 9/10/2014

Table 66: Control Point 6 Data 4/1/2014

Control Point 6				
4/1/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.18	1.86	0.68	1.9946
1.5	1.1365	1.68	0.5435	1.4511
3	1.127	1.69	0.563	0.8881
4.5	1.1368	1.59	0.4532	0.4349
6	1.345	1.62	0.275	0.1599
7.5	1.4	1.565	0.165	-0.0051
9	1.361	1.6	0.239	-0.2441
10.5	1.41	1.555	0.145	-0.3891
12	1.355	1.6	0.245	-0.6341
13.5	1.415	1.55	0.135	-0.7691
15	1.425	1.54	0.115	-0.8841
16.5	1.429	1.54	0.111	-0.9951
18	1.43	1.53	0.1	-1.0951

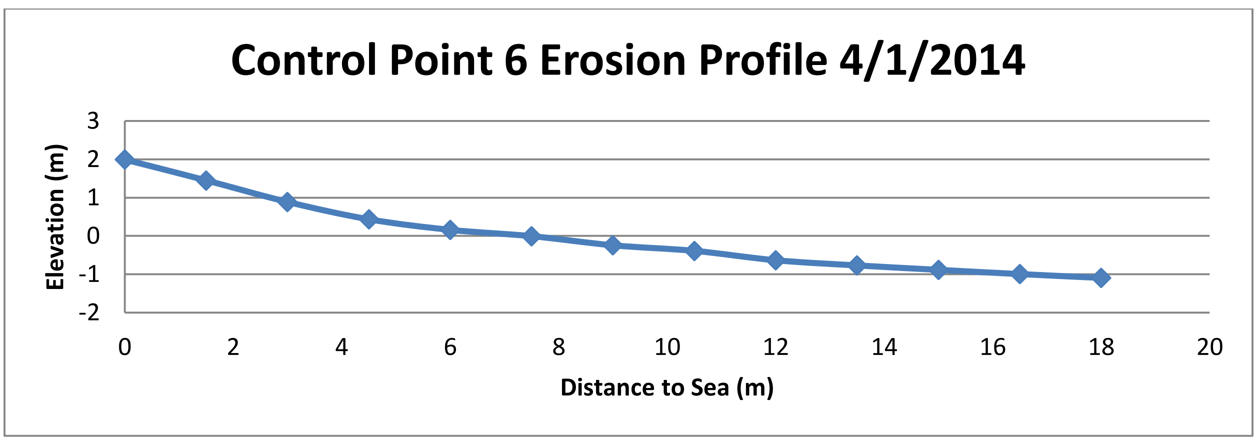

Figure 75: Control Point 6 Erosion Profile 4/1/2014

Table 67: Control Point 6 Data 4/16/2014

Control Point 6				
4/16/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	0.99	1.69	0.7	1.9746
1.5	1.27	1.42	0.15	1.8246
3	1.08	1.6	0.52	1.3046
4.5	1.215	1.46	0.245	1.0596
6	1.23	1.44	0.21	0.8496
7.5	1.21	1.46	0.25	0.5996
9	1.22	1.45	0.23	0.3696
11	1.28	1.39	0.11	0.2596
12	1.29	1.38	0.09	0.1696
14	1.26	1.415	0.155	0.0146
15	1.24	1.43	0.19	-0.1754
17	1.26	1.41	0.15	-0.3254

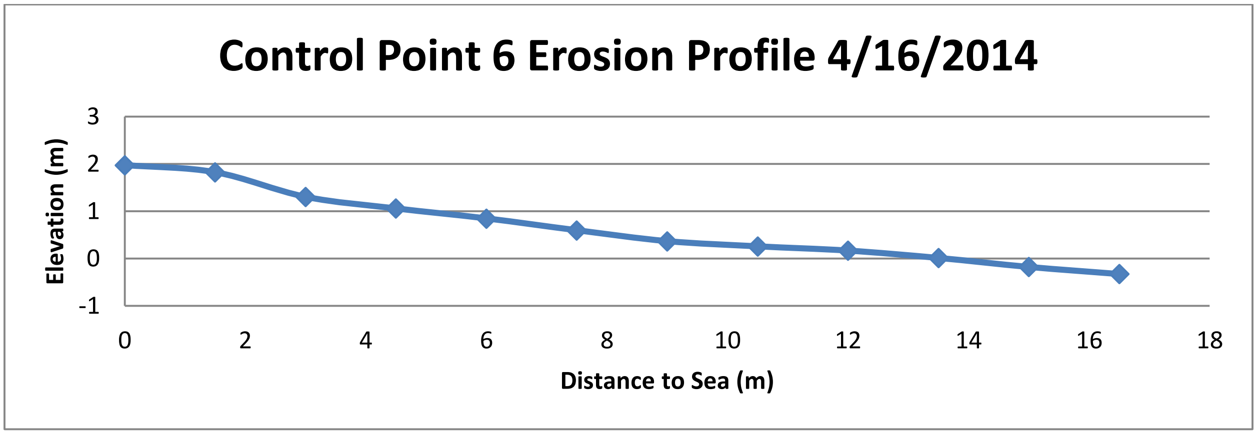

Figure 76: Control Point 6 Erosion Profile 4/16/2014

Table 68: Control Point 6 Data 4/22/2014

Control Point 6				
4/22/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	0.97	1.635	0.665	2.0096
1.5	1.13	1.455	0.325	1.6846
3	1.08	1.5	0.42	1.2646
4.5	1.16	1.435	0.275	0.9896
6	1.15	1.425	0.275	0.7146
7.5	1.17	1.41	0.24	0.4746
9	1.14	1.44	0.3	0.1746
10.5	1.156	1.43	0.274	-0.0994
12	1.22	1.365	0.145	-0.2444
13.5	1.24	1.345	0.105	-0.3494

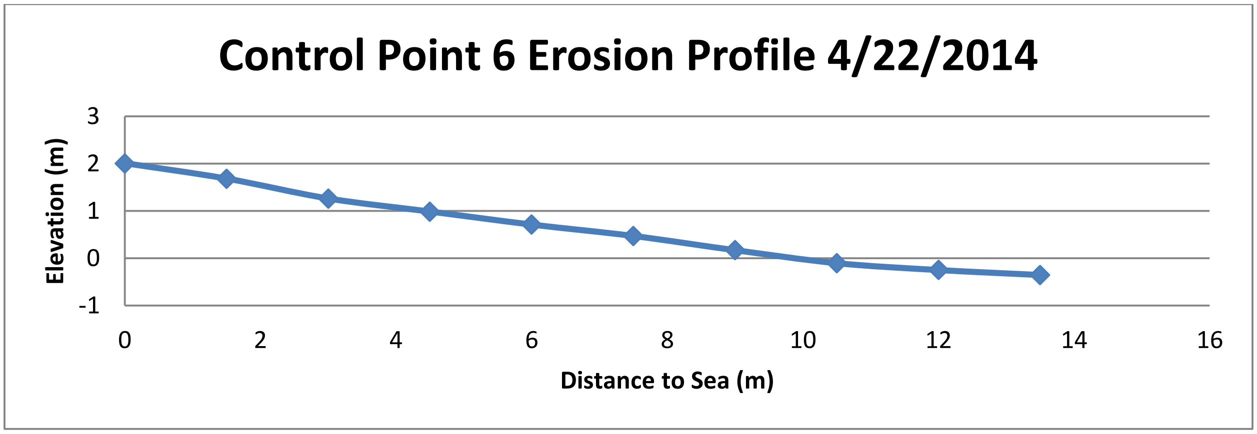

Figure 77: Control Point 6 Erosion Profile 4/22/2014

Table 69: Control Point 6 Data 4/29/2014

Control Point 6				
4/29/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.11	1.83	0.72	1.9546
1.5	1.305	1.65	0.345	1.6096
3	1.28	1.65	0.37	1.2396
4.5	1.32	1.61	0.29	0.9496
6	1.32	1.6	0.28	0.6696
7.5	1.355	1.57	0.215	0.4546
9	1.3	1.63	0.33	0.1246
10.5	1.32	1.61	0.29	-0.1654
12	1.47	1.45	-0.02	-0.1454
13.5	1.43	1.49	0.06	-0.2054
15	1.32	1.61	0.29	-0.4954

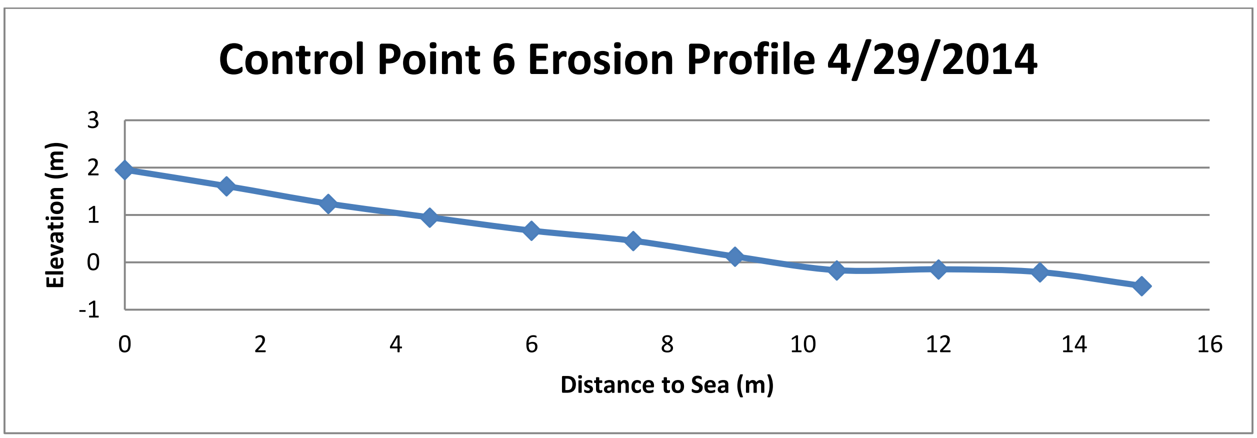

Figure 78: Control Point 6 Erosion Profile 4/29/2014

Table 70: Control Point 6 Data 5/6/2014

Control Point 6				
5/6/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.15	1.86	0.71	1.9646
1.5	1.38	1.64	0.26	1.7046
3	1.29	1.71	0.42	1.2846
4.5	1.4	1.59	0.19	1.0946
6	1.34	1.6	0.26	0.8346
7.5	1.37	1.62	0.25	0.5846
9	1.35	1.645	0.295	0.2896
10.5	1.38	1.61	0.23	0.0596
12	1.45	1.545	0.095	-0.0354
13.5	1.425	1.565	0.14	-0.1754
15	1.45	1.545	0.095	-0.2704

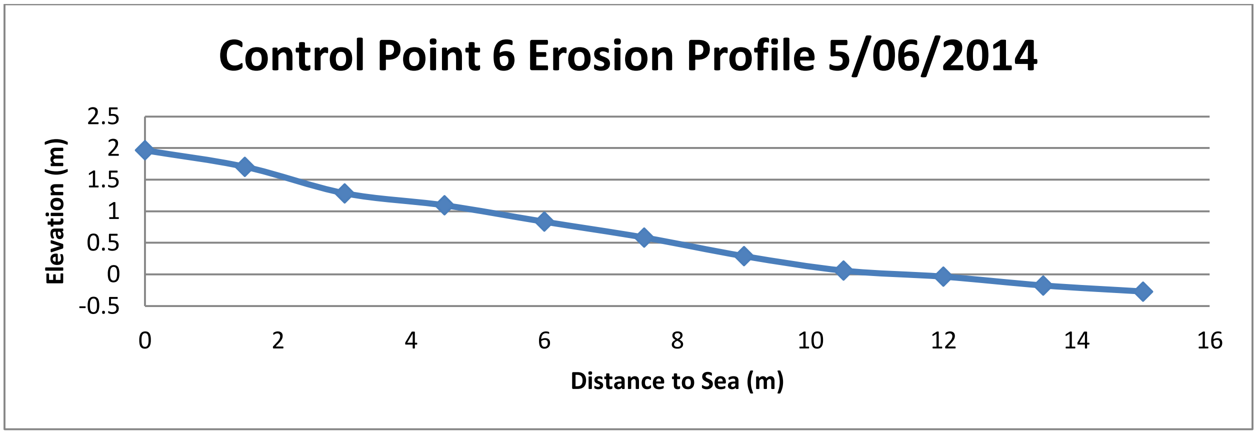

Figure 79: Control Point 6 Erosion Profile 5/6/2014

Table 71: Control Point 6 Data 5/20/2014

Control Point 6				
5/20/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.055	1.75	0.695	1.9796
1.5	1.28	1.53	0.25	1.7296
3	1.2	1.61	0.41	1.3196
4.5	1.302	1.51	0.208	1.1116
6	1.225	1.58	0.355	0.7566
7.5	1.295	1.51	0.215	0.5416
9	1.2075	1.6	0.3925	0.1491
10.5	1.3175	1.49	0.1725	-0.0234
12	1.335	1.48	0.145	-0.1684
13.5	1.365	1.45	0.085	-0.2534
15	1.375	1.45	0.075	-0.3284

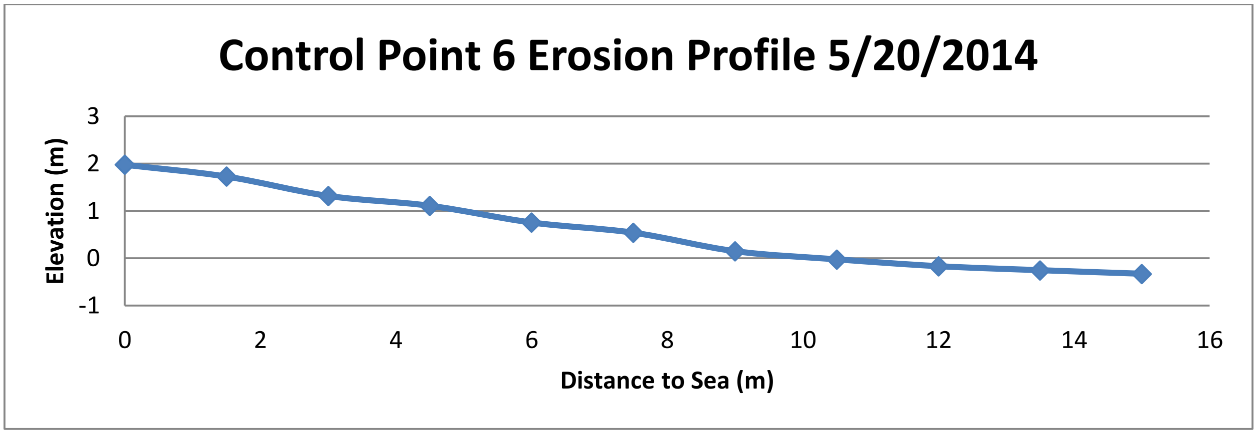

Figure 80: Control Point 6 Erosion Profile 5/20/2014

Table 72: Control Point 6 Data 5/27/2014

Control Point 6				
5/27/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.115	1.815	0.7	1.9746
1.5	1.33	1.59	0.26	1.7146
3	1.2425	1.67	0.4275	1.2871
4.5	1.325	1.59	0.265	1.0221
6	1.3275	1.585	0.2575	0.7646
7.5	1.31	1.6	0.29	0.4746
9	1.2875	1.625	0.3375	0.1371
10.5	1.37	1.54	0.17	-0.0329
12	1.4	1.5	0.1	-0.1329
13.5	1.42	1.4925	0.0725	-0.2054
15	1.465	1.45	-0.015	-0.1904
16.5	1.47	1.44	-0.03	-0.1604
18	1.41	1.5025	0.0925	-0.2529
19.5	1.495	1.53	0.035	-0.2879
21	1.405	1.52	0.115	-0.4029
22.5	1.39	1.5375	0.1475	-0.5504

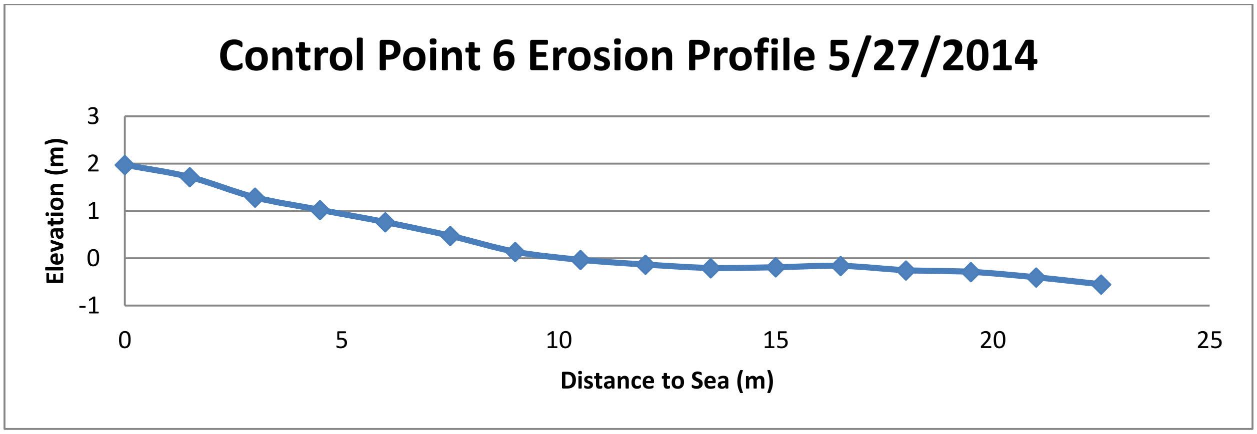

Figure 81: Control Point 6 Erosion Profile 5/27/2014

Table 73: Control Point 6 Data 6/11/2014

Control Point 6				
6/11/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	0.865	1.57	0.705	1.9696
1.5	1.12	1.335	0.215	1.7546
3	1.02	1.41	0.39	1.3646
4.5	1.12	1.315	0.195	1.1696
6	1.03	1.396	0.366	0.8036
7.5	1.08	1.36	0.28	0.5236
9	1.05	1.37	0.32	0.2036
10.5	1.13	1.29	0.16	0.0436
12	1.195	1.23	0.035	0.0086
13.5	1.14	1.29	0.15	-0.1414
15	1.12	1.31	0.19	-0.3314
16.5	1.1	1.33	0.23	-0.5614
18	1.115	1.275	0.16	-0.7214

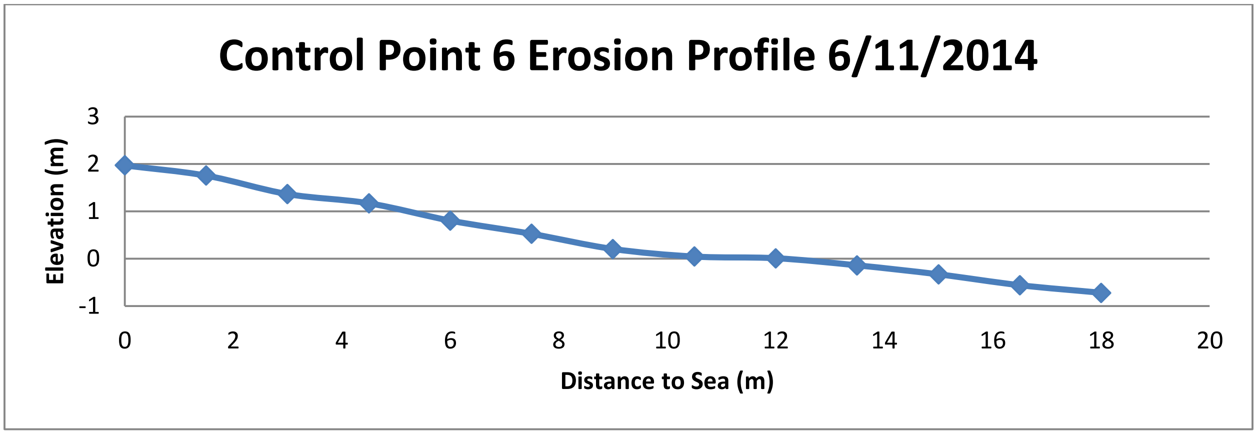

Figure 82: Control Point 6 Erosion Profile 6/11/2014

Table 74: Control Point 6 Data 6/26/2014

Control Point 6				
6/26/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.165	1.88	0.715	1.9596
1.5	1.43	1.62	0.19	1.7696
3	1.3	1.735	0.435	1.3346
4.5	1.435	1.65	0.215	1.1196
6	1.31	1.72	0.41	0.7096
7.5	1.42	1.62	0.2	0.5096
9	1.32	1.715	0.395	0.1146
10.5	1.43	1.605	0.175	-0.0604
12	1.5	1.535	0.035	-0.0954
13.5	1.43	1.615	0.185	-0.2804
15	1.425	1.62	0.195	-0.4754
16.5	1.4	1.64	0.24	-0.7154
18	1.47	1.58	0.11	-0.8254

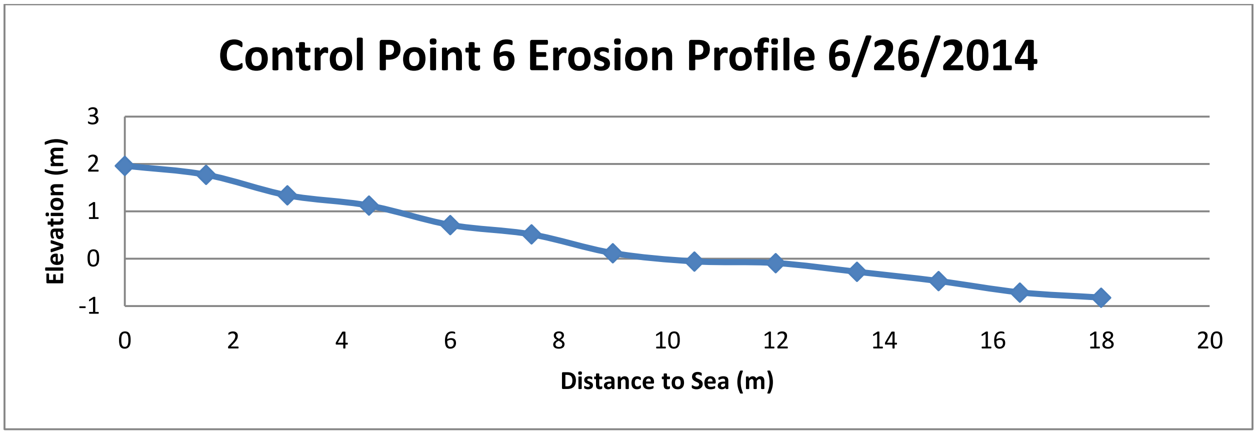

Figure 83: Control Point 6 Erosion Profile 6/26/2014

Table 75: Control Point 6 Data 8/13/2014

Control Point 6				
8/13/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.04	1.73	0.69	1.9846
1.5	1.265	1.5	0.235	1.7496
3	1.17	1.58	0.41	1.3396
4.5	1.235	1.51	0.275	1.0646
6	1.21	1.54	0.33	0.7346
7.5	1.205	1.54	0.335	0.3996
9	1.25	1.5	0.25	0.1496
10.5	1.34	1.41	0.07	0.0796
12	1.34	1.41	0.07	0.0096
13.5	1.37	1.38	0.01	-0.0004
15	1.3	1.45	0.15	-0.1504
16.5	1.295	1.45	0.155	-0.3054
18	1.295	1.45	0.155	-0.4604
19.5	1.305	1.44	0.135	-0.5954
21	1.315	1.435	0.12	-0.7154
22.5	1.335	1.41	0.075	-0.7904

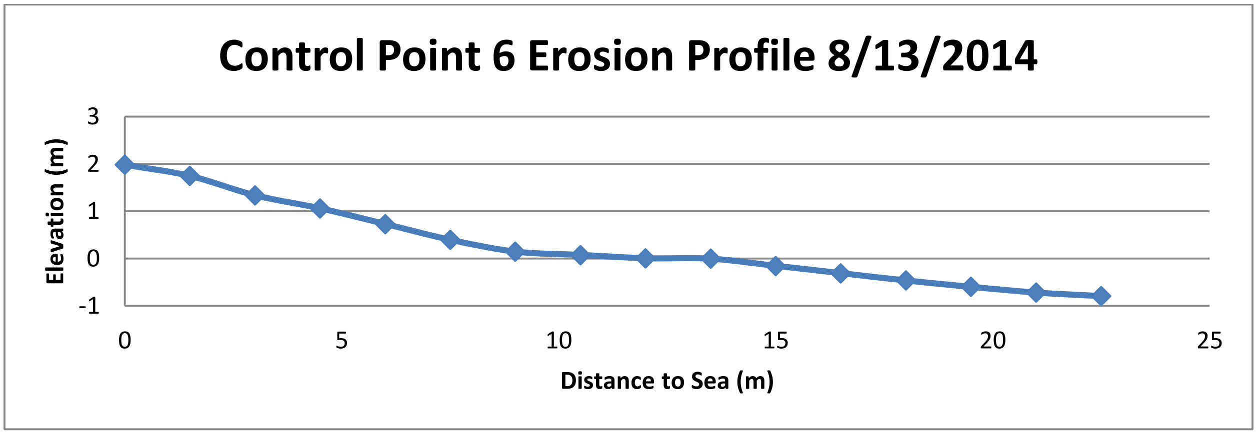

Figure 84: Control Point 6 Erosion Profile 8/13/2014

Table 76: Control Point 6 Data 8/27/2014

Control Point 6				
8/27/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
Profile A (m)			Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.07	1.77	0.7	1.9746
1.5	1.28	1.56	0.28	1.6946
3	1.25	1.59	0.34	1.3546
4.5	1.27	1.56	0.29	1.0646
6	1.24	1.59	0.35	0.7146
7.5	1.26	1.565	0.305	0.4096
9	1.27	1.54	0.27	0.1396
10.5	1.36	1.46	0.1	0.0396
12	1.38	1.44	0.06	-0.0204
13.5	1.38	1.425	0.045	-0.0654
15	1.36	1.43	0.07	-0.1354
16.5	1.45	1.35	-0.1	-0.0354
18	1.29	1.51	0.22	-0.2554
19.5	1.28	1.51	0.23	-0.4854
21	1.32	1.47	0.15	-0.6354

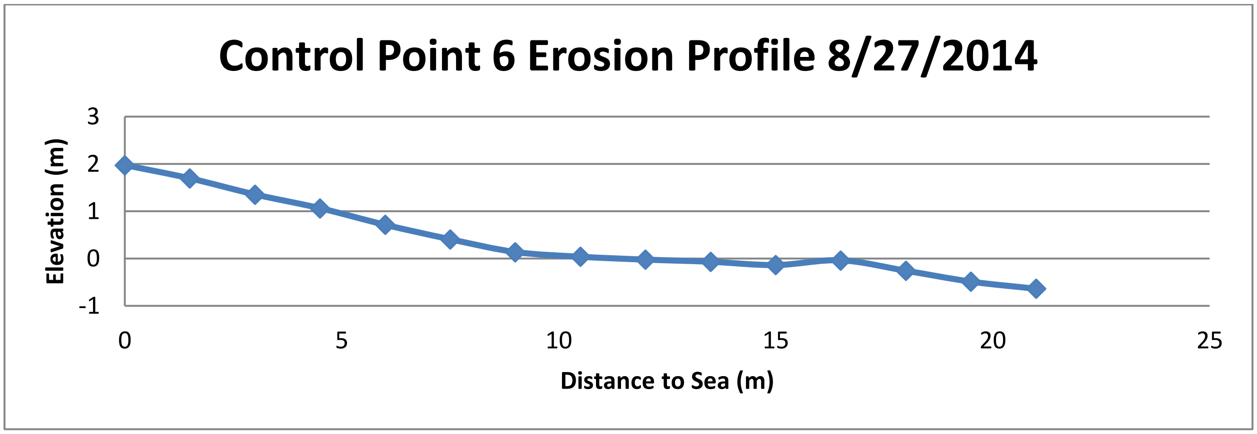

Figure 85: Control Point 6 Erosion Profile 8/27/2014

Table 77: Control Point 6 Data 9/10/2014

Control Point 6				
9/10/2014				
x	213732.8079			
y	2354309.07			
z	2.6746			
	Profile A (m)		Processed Data (m)	
X	Land	Sea	Differential	Final Value
0	1.05	1.745	0.695	1.9796
1.5	1.25	1.54	0.29	1.6896
3	1.21	1.58	0.37	1.3196
4.5	1.29	1.495	0.205	1.1146
6	1.2	1.585	0.385	0.7296
7.5	1.27	1.52	0.25	0.4796
9	1.19	1.595	0.405	0.0746
10.5	1.33	1.45	0.12	-0.0454
12	1.36	1.41	0.05	-0.0954
13.5	1.345	1.43	0.085	-0.1804
15	1.395	1.385	-0.01	-0.1704
16.5	1.38	1.4	0.02	-0.1904
18	1.41	1.365	-0.045	-0.1454
19.5	1.3	1.48	0.18	-0.3254
21	1.355	1.42	0.065	-0.3904
22.5	1.36	1.42	0.06	-0.4504
24	1.345	1.44	0.095	-0.5454
25.5	1.33	1.46	0.13	-0.6754
27	1.32	1.475	0.155	-0.8304
28.5	1.32	1.475	0.155	-0.9854

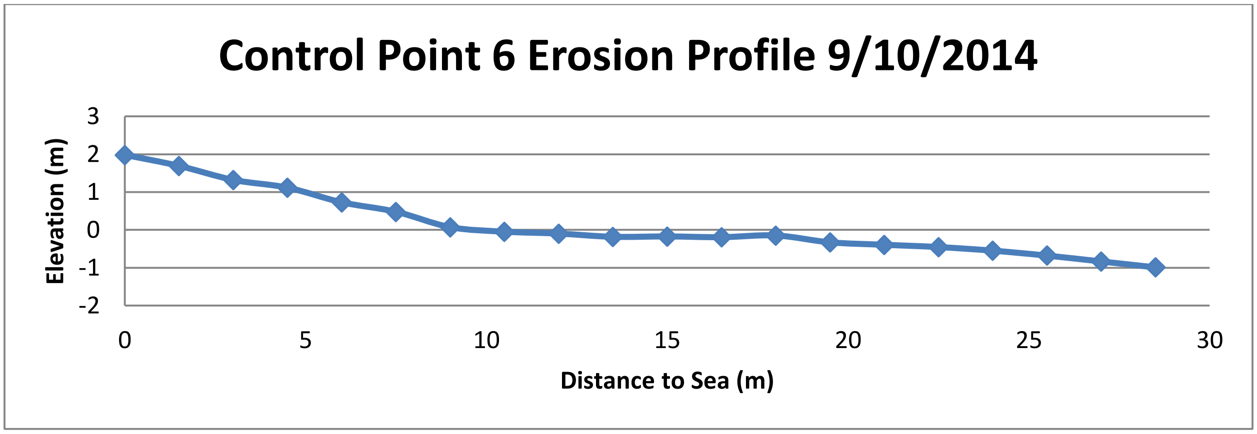

Figure 86: Control Point 6 Erosion Profile 9/10/2014

Table 78: Control Point 1 Volume Change (CEDAS)

Volume Change:	
Above Datum:	-9.722 cu. m/m
Below Datum:	-2.679 cu.m/m
Total Volume:	-12.401 cu.m/m
Shoreline Change:	-6.76 m
From:	24.98 m
To:	18.21 m

Table 79: Control Point 2 Volume Change (CEDAS)

Volume Change:	
Above Datum:	-6.471 cu. m/m
Below Datum:	0.262 cu.m/m
Total Volume:	-6.209 cu.m/m
Shoreline Change:	0.82 m
From:	18.81 m
To:	19.62 m

Table 80: Control Point 3 Volume Change (CEDAS)

Volume Change:	
Above Datum:	-0.540 cu. m/m
Below Datum:	0.358 cu.m/m
Total Volume:	-0.182 cu.m/m
Shoreline Change:	7.48 m
From:	19.17 m
To:	26.65 m

Table 81: Control Point 5 Volume Change (CEDAS)

Volume Change:	
Above Datum:	-2.031 cu. m/m
Below Datum:	0.437 cu.m/m
Total Volume:	-1.594 cu.m/m
Shoreline Change:	0.49 m
From:	20.71 m
To:	21.20 m

Table 82: Control Point 6 Volume Change (CEDAS)

Volume Change:	
Above Datum:	3.682 cu. m/m
Below Datum:	5.588 cu.m/m
Total Volume:	9.269 cu.m/m
Shoreline Change:	2.48 m
From:	7.45 m
To:	9.93 m

Table 83: Control Point 1 Volume and Contour Data (CEDAS)

Profile	Date	Volume (cu. m/m)	Contour Location (m)
1	4/1/2014	37.994	24.98
1	9/10/2014	28.031	18.21

Table 84: Control Point 2 Volume and Contour Data (CEDAS)

Profile	Date	Volume (cu. m/m)	Contour Location (m)
2	4/1/2014	21.605	18.81
2	9/10/2014	15.133	19.62

Table 85: Control Point 3 Volume and Contour Data (CEDAS)

Profile	Date	Volume (cu. m/m)	Contour Location (m)
3	4/1/2014	22.365	19.17
3	9/10/2014	23.205	26.65

Table 86: Control Point 4 Volume and Contour Data (CEDAS)

Profile	Date	Volume (cu. m/m)	Contour Location (m)
4	4/1/2014	10.258	15.55
4	9/10/2014	24.379	23.59

Table 87: Control Point 5 Volume and Contour Data (CEDAS)

Profile	Date	Volume (cu. m/m)	Contour Location (m)
5	4/1/2014	18.783	20.71
5	9/10/2014	16.752	21.2

Table 88: Control Point 6 Volume and Contour Data (CEDAS)

Profile	Date	Volume (cu. m/m)	Contour Location (m)
6	4/1/2014	5.893	7.45
6	9/10/2014	9.575	9.93